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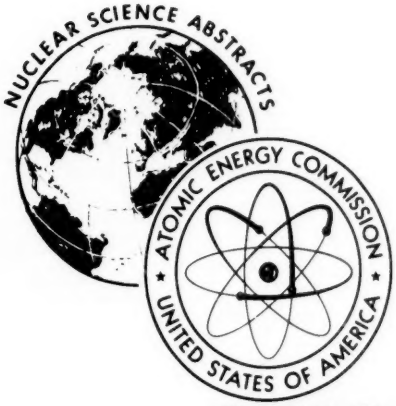

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NUCLEAR SCIENCE ABSTRACTS

Volume 20 Number 18

Abstracts 32892–35191

September 30, 1966

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A title page for Volume 20, Numbers 13–18, is included at the back of this issue for use in binding the third quarter of this volume.

CORRECTIONS

NSA Vol. 17, No. 16, p. 3599, Abst. No. 27358, line 4 ... Should read ... Japan, 17: Suppl. B-II, 20-2(1962). (IS-365)

NSA Vol. 19, No. 10, p. 2131, Abst. No. 17445, line 2 ... Should read ... CONFERENCE, FEBRUARY 6, 7, AND 8, 1964. PARTS I & II. ... line 4 ... Should read... (Nov. 30, 1964). (CONF-641113(Pts. 1 & 2)

NSA Vol. 19, No. 17, Abst. No. 33514, line 1 ... Should read ... (COO-578-17) MAGNETIC PROPERTIES OF ... line 4 ... Should read ... June 5, 1965. Contract AT (11-1)-578. 47p. (IITRI-

NSA Vol. 20, No. 1, p. 53, Abst. No. 353, line 4 ... Should read ... J. Polymer Sci. Pt. B, 3: 863-70(Oct. 1965).

NSA Vol. 20, No. 1, p. 91, Abst. No. 611, line 2 ... Should read ... Vaclav. Pokroky Mat. Fys. Astron., 10: 160-8(1965). (In

NSA Vol. 20, No. 2, p. 248, Abst. No. 1864, line 3 ... Should read ... tional Lab., Tenn.). Trans. Amer. Nucl. Soc., 8: 335(Nov. 1965).

NSA Vol. 20, No. 2, p. 372, Abst. No. 2945, line 3 ... Should read ... schule, Vienna). Atomkernenergie, 10: 243-6(July-Aug.

NSA Vol. 20, No. 2, p.372, Abst. No. 2946, line 3 ... Should read ... schule, Vienna). Atomkernenergie, 10: 247-8(July-Aug.

NSA Vol. 20, No. 3, p. 468, Abst. No. 3824, line 4 ... Should read ... Univ. School of Medicine, Chicago). J. Amer. Med. Ass., 194:

NSA Vol. 20, No. 3, p. 545, Abst. No. 4404, line 3 ... Should read ... Kvokva, I. M.; Layner, V. I. Translated from Zashchita

NSA Vol. 20, No. 14, p. 3121, Abst. No. 25532, line 5 ... Should read ... 120; DM 100; £ 8.16.0; $25.00. (CONF-640618)

Volume 20, Number 18, September 30, 1966

NUCLEAR SCIENCE ABSTRACTS

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Volume 20, Number 18 September 30, 1966

NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

Refer also to abstracts 33223–33226, 33648, and 33713.

32892 (AD–627686) BIOASTRONAUTICS AND THE EXPLORATION OF SPACE. The Proceedings of the Third International Symposium Held at San Antonio, Texas, November 16–18, 1964. Bedwell, Theodore C. Jr.; Strughold, Hubertus (eds.) (Aerospace Medical Div., Brooks AFB, Tex.). Dec. 1965. Contract AF41(609)-2293. 640p. (CONF-641131). CFSTI $9.40 cy, $2.75 mn.

Separate abstracts were prepared on 5 papers that discuss biological responses to space flight conditions. Twenty-eight papers discuss other aspects of space exploration. (C.H.)

For abstracts of individual papers see: 32893, 32894, 32962, 32963, and 34004.

32893 (AD-627686, pp 357-84) MEDICAL INVESTIGATIONS ON SPACE SHIPS "VOSTOK" AND "VOSKHOD." Gazenko, O. (Akademiya Nauk SSSR).

Medical and physiological studies conducted during manned flights of the Russian spaceships Vostok and Voskhod from 1961 through 1964 are reviewed. The problems studied included the influence of individual and combined space flight factors on physiological functions and adaptive mechanisms of the astronauts; the effectiveness and reliability of life support systems and medical monitoring equipment; man's proficiency and ability to perform tasks related to navigation, systems control, and operation of scientific equipment; ways to increase human tolerance to space flight factors; and the evaluation of criteria and effectiveness of astronauts selection and training programs. Observations made on 9 astronauts during approximately 500 hours of space flight are summarized. (C.H.)

32894 (AD-627686, pp 435-52) BIOLOGIC INVESTIGATIONS ON SPACESHIPS "VOSTOK" AND "VOSKHOD." Antipov, V. V. (Akademiya Nauk SSSR).

Results are summarized from a number of studies on the influence of the combined effects of space flight factors such as acceleration, vibration, and noise on biological systems exposed during the flights of Voskhod, Vostok 2, and other space craft, Earth satellites, high-altitude balloons, and geophysical rockets. Specially designed life support systems were used to eliminate the effects of environmental factors such as temperature, humidity, and changes in the gaseous composition of the atmosphere. Biological systems studied included dogs, guinea pigs, mice, rats, cultures of animal and human cells, Drosophila, Tradescantia microspores, chlorella cultures, and seeds of higher plants. The specimens were used for physiological, biochemical, morphological, cytological, and genetic studies and for comparison with specimens exposed in the laboratory to simulated space flight conditions. It was concluded that 5 days of weightlessness is not harmful to the viability of the organisms tested and that coordination and spatial orientation of astronauts are not affected by weightlessness. However, no data are available on the effects of prolonged weightlessness on body functions and it is pointed out that solution of radiobiologic problems is extremely important for the success of future space flights. (57 references). (C.H.)

32895 (TT–65-50309/4) ACTA BIOCHIMICA POLONICA. Translation of Acta Biochim. Pol., 12: 279-412(1965). 154p. CFSTI $5.00 cy, $1.00 mn.

This volume of Acta Biochimica contains 41 papers that report the results of various biochemical investigations. One paper was abstracted previously and appeared in NSA Vol. 20 as number 18301. (C.H.)

32896 THERMAL DENATURATION OF ESCHERICHIA COLI DNA–DNA HYBRIDS IN ORDINARY AND HEAVY WATER. Maslova, R. N.; Varshavsky, Ya. M. (Inst. of Molecular Biology, Moscow). Biochim. Biophys. Acta, 119: 633-6(June 22, 1966).

Studies were made on the thermal fractionation of fragments of labeled, denatured, E. coli DNA complexed with E. coli DNA trapped in agar gel. From the results it was found that the DNA-DNA hybrids are more stable in heavy water. The average difference between the maxima of elution curves for three different experiments was 2.0° with a deviation of ±0.5°. It is suggested that the increase in thermostability of DNA-DNA hybrids in heavy water is due to a difference of strength of deuterium and hydrogen bonds in incompletely denatured DNA. (P.C.H.)

32897 GENETIC CONTROL OF FLAGELLAR STRUCTURE IN CHLAMYDOMONAS REINHARDII. Warr, J. R.; McVittie, A.; Randall, John; Hopkins, J. M. (London Univ.). Genet. Res., 7: 335-51(June 1966).

Seventeen non-motile isolated strains of Chlamydomonas reinhardii and thirty-six newly isolated strains were examined in the electron microscope for structural abnormalities of the flagella. Fourteen of them have straight, paralyzed flagella in which the central fibres are replaced by an irregular core of disorganized material. The fourteen mutations map at four unlinked loci. Some of them are leaky; light and electron microscope observations on leakiness are described. In the former case leakiness was measured by the proportion of motile cells, and in the latter by the proportion of intact center fibres seen in transverse sections. The degree of leakiness is to some extent characteristic of particular loci. A partial suppressor of some of these mutations was isolated which acts on all the mutant alleles at two loci and to a much lesser extent on four out of five alleles at a third locus. (auth)

32898 ROLE OF MUTAGEN SPECIFICITY IN MUTATION BREEDING. Auerbach, C. (Inst. of Animal Genetics, Edinburgh). Genetika, No. 1, 3-11(Jan. 1966). (In Russian).

It is stated that for the purposes of mutation breeding, mutagen specificity at the level of DNA is of no value. A more promising approach is offered by manipulation of the

mutation process at some secondary level. It is shown by examples that this can be done through choice of physiological and environmental conditions, choice of genetical background, variation in dose of a single mutagen, and combination treatment with several mutagens. Practical success along these lines requires no clear understanding of the way in which specificity is produced. If, in any organism, a method is found that increases the proportion of desirable mutant phenotypes, then the value of this method is independent of the level at which it imposes specificity. From the standpoint of fundamental genetics, on the contrary, thorough analysis of the causes of mutagen specificity in many different cases seems to be one of the best tools for elucidating the complex process by which a sudden change in genetic information is translated into a clone of mutant cells. (auth)

32899 SPONTANEOUS ACTINOPHAGE CB2 MUTANTS, ABLE TO LYSE PHAGE-RESISTANT ACTINOMYCES ERYTHREUS STRAINS. Torosyan, M. V.; Alikhanyan, S. I. (Kurchatov Inst. of Atomic Energy, Moscow). Genetika, No. 5, 152-60(May 1966). (In Russian).

A series of actinophage CB2 spontaneous mutants having an altered action spectrum were isolated. These mutants are able to lyse Actinomyces erythreus strains resistant to phage CB2, obtained by means of mutagen action. A comparative study of spontaneous phage mutants and actinophage CB2 showed their philogenetical relationship, which was confirmed by the following common features: morphology of negative colonies; character of secondary growth; temperature optimum of multiplication; and similar sensitivity to citrates. The isolated mutants differ from actinophage CB2 with respect to the spectrum of lytic action, response to temperature in activation, and uv irradiation. (auth)

32900 EXPERIENCE IN THE TREATMENT OF RHEUMATOID ARTHRITIS PATIENTS IN THE HIROSHIMA ATOMIC BOMBING HOSPITAL. Takagishi, Naoto; Tamaru, Takuko; Kitzukawa, Makimoto; Kunikisa, Yasuo; Ootani, Takeshi (Hiroshima Atomic Bomb Hospital). Nagasaki Igakkai Zasshi, 38: Suppl., 96-8(Dec. 1963). (In Japanese).

As assessment was made of the incidence, severity, and response to treatment of rheumatoid survivors among atomic bombing survivors and controls. In this hospital, from Sept. 1, 1951 to Aug. 31, 1952, there were 3920 noncasualties and 340 atomic bombing casualties among the outpatients, and there were 60 rheumatoid arthritis patients among the non-casualties (1.5%) and 29 among the casualties (8.5%). This is a significant difference. The male/female ratio was 1:4, which is without significant difference between the two groups. Among non-casualties the 20- to 40-yr. age group predominated while rheumatoid cases were largely in age group of 50 to 60 years in casualties. In 19 out of 29 (65%) casualty patients the arthritis was of the classical type, a significantly higher proportion than the 26 out of 60 (43%) cases among noncasualty patients. Ten out of 29 casualty patients were in the highly incapacitated group (class IV or V) compared with 6 out of 60 noncasualty patients. Eleven out of 27 casualty patients were in the more progressive stages (IV or V) as compared with 10 out of 60 noncasualty patients. Treatment with plastic surgery was highly effective in noncasualty patients (in 13 out of 47 with Grade II arthritis) but less effective in the casualty group (2 out of 22 with Grade II). Adrenocorticoid hormone therapy was effective in the other cases. (BBB)

32901 QUANTUM YIELD OF OXYGEN EVOLUTION AND THE EMERSON ENHANCEMENT EFFECT IN DEUTERATED CHLORELLA. Bedell, Glenn; Govindjee (Univ. of Illinois, Urbana). Science, 152: 1383-4(June 3, 1966).

The maximum quantum yield of oxygen evolution in deuterated chlorella is found to be 0.075, while normal chlorella showed, in parallel experiments, a value of 0.10. Deuterated Chlorella vulgaric showed a decline in the quantum yield of oxygen evolution (red drop) beginning at 680 millimicrons and a clear Emerson enhancement effect qualitatively similar to that obtained in normal chlorella cells. However, the ratio of quantum yield at 680 to that at 710 millimicrons was about 1.5 times higher in normal than in deuterated chlorella cells. Action spectra of the Emerson enhancement effect in deuterated chlorella also are qualitatively similar to those of normal cells. (auth)

32902 BIOLOGICAL IRRADIATIONS USING POSITIVE-ION ACCELERATORS. England, L. D. (Texas Nuclear Corp., Austin); Morgan, I. L.; Launer, R. L.; Benjamin, R. W. Trans. Amer. Nucl. Soc., 9: 79(June 1966).

32903 ELECTRON ENERGY DISTRIBUTION IN FINITE SLABS. Kniedler, M. J. (National Bureau of Standards, Gaithersburg, Md.); Silverman, Joseph. Trans. Amer. Nucl. Soc., 9: 84-5(June 1966).

32904 EFFECTS OF AMBIENT PRESSURE ON THE BIOLOGICAL RESPONSE OF MICE TO AIR BLAST. Damon, Edward George. Albuquerque, N. Mex., Univ. of New Mexico, 1965. 69p.

Thesis.

Mice were mounted on the end plate of the expansion chamber of an air-driven shock tube and exposed to sharp-rising overpressures of "long" duration while under initial pre-blast pressures ranging from 7 to 42 psi absolute. The shock pressures were recorded by piezoelectric pressure transducers. A total of 672 mice were exposed to pressure changes in two series of experiments. In one series, the animals were held under the initial pressure for one hour following the blast before being returned to the ambient pressure level of the laboratory. In the second series, the pressure on the mice was returned to ambient immediately following blast exposure. In both series, animal tolerance, expressed as LD_{50} overpressures, increased linearly with increasing initial pressures. The LD_{50}-1-hour gauge pressures in the first series were 20.3, 31.0, 44.5, 55.4, and 91.8 psi for initial pressures of 7, 12, 18, 24, and 42 psia, respectively. The LD_{50} pressures for the second series were 22.7, 37.9, 53.6, 61.3, and 68.4 psi for initial pressures of 7, 18, 30, 36, and 42 psia, respectively. These results indicated that pressurization of animals soon after blast exposure resulted in a decrease in the mortality whereas decompression resulted in increased lethality. Practical and theoretical implications of the study are discussed. A promising but tentative procedure for scaling biological blast effects as a function of altitude was presented. (Dissertation Abstr.)

32905 ACTIONS CHIMIQUES ET BIOLOGIQUES DES RADIATIONS. Neuvieme Serie. (Chemical and Biological Actions of Radiations. Ninth Series). Paris, Masson et Cie Editeurs, 1966. 200p. 66 F.

Research techniques applicable to radiobiological studies discussed include flash photolytic studies, vacuum-ultraviolet photolysis of paraffin hydrocarbons, intermolecular transfer of electron excitation energy between complex molecules in solutions, and the long-lived fluorescence of organic compounds. (C.H.)

32906 METHODS OF ANIMAL EXPERIMENTATION. VOLUME II. Gay, William I. (ed.). New York, Academic Press, 1965. 620p. $18.50.

Fundamental and new techniques of animal experimentation in various research fields are discussed in terms of specific research methods by experts in experimental methods. Topics discussed include tumor transplantation; organ transplantation; parabiosis; the care and use of hibernating animals; high-altitude studies; the care and growth of animals during chronic centrifugation; controlled exercise; the infection of animals with bacteria, fungi, and viruses; and the electronic monitoring of physiological phenomena in experimental animals. The chapters on radiation hygiene and the use of ionizing radiation for measuring biological phenomena were abstracted previously and appeared in NSA Vol. 20 as numbers 16296 and 14386, respectively. (C.H.)

Ecology

Refer also to abstract 33260.

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstract 33104.

32907 (ORO-648, pp 62-70) LARGE ANIMAL NUTRITION. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

The metabolism of fission products and chemically related nuclides was studied in bovine, ovine, and porcine species. The influence and interaction of known dietary factors and irradiation were used to evaluate specific effects. Of economic importance is the fact that these species comprise most of the animal protein consumed in the United States. Research is reported on: effects of chronic $^{144}Ce-^{144}Pr$ toxicity in lambs; intestinal carbohydrases in the mucosal cells of the duodenum, jejunum, and ileum of mature sheep, ^{99}Mo and ^{185}W metabolism in sheep and swine; investigation of total and ^{35}S-labeled mucopolysaccharides in kidney and intestinal mucosal cells of sheep, swine, and cattle; zinc and copper metabolism in tissues of neutron irradiated animals; life span of porcine erythrocytes as estimated from ^{75}Se turnover; and metabolism of ^{89}Sr and ^{45}Ca in young pigs after whole-body irradiation. (H.G.D.)

32908 (ORO-648, pp 71-90) DAIRY NUTRITION. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Pathways of fission product entry into milk were examined and possible metabolic controls were established. Research is reported on: effects of single ^{131}I doses (200 uc/kg body wt) on iodine metabolism in dairy heifers; status of dairy cows one year after administration of toxic levels of ^{131}I; distributions and binding of radiocerium in the digestive tracts of dairy cattle; fractionated gamma irradiation of lactating dairy cows; the effects of the composition of food rations on the concentration of Na, K, Ca, Mg, P, and N in the intestinal contents from calves, the effects of irradiation and drugs on erythrocyte chimerism and immunologic tolerance in cattle twins; and the functional effectiveness of kidney transplantation in twin calves. (H.G.D.)

32909 (ORO-648, pp 91-102) POULTRY NUTRITION. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Because poultry is potentially an excellent emergency source of animal protein, metabolic pathways are studied, and ways of inducing disturbances of normal fission product pathways were considered. Progress is reported on studies of: toxicity of ^{131}I and $^{90}Sr-^{90}Y$ to avian embryos; gamma irradiation of chick embryos; gamma and neutron irradiation of young chicks; and the role of lymphoid tissue in providing radioprotection in poultry. (H.G.D.)

32910 DISAPPEARANCE MEASUREMENTS, A METHOD FOR STUDYING PERCUTANEOUS ABSORPTION OF ISOTOPE-LABELED COMPOUNDS EMITTING GAMMA-RAYS. Wahlberg, Jan E. (National Inst. of Public Health, Stockholm). Acta Dermato-Venerol., 45: 397-414(1965).

Detailed data are given on the techniques of measurement, instrumentation and evaluation of results in studies on the absorption of numerous radioisotopes through skin. An assessment of the radiation dose to the skin from topically applied radioisotopes is also given. Data are provided for results in guinea pigs using ^{22}Na, ^{51}Cr, ^{58}Co, ^{65}Zn, ^{110m}Ag, ^{115m}Cd, and ^{203}Hg. The method applied (disappearance measurements) implies that the radioactivity above a topical deposit of isotope-labeled penetrants on the skin is recorded continuously by a scintillation detector. The decrease in activity is an indication of absorption. To appraise the results obtained, the significance of the following factors and sources of error are discussed: geometry, skin and organ content of absorbed material, collimators, analysis and subjectivity in the evaluation of disappearance curves, time constant, concentration, vehicle, applied volume, temperature, anesthesia, lack of circulation, clipping, glue, radiation damage, adsorption on glass, and leakage. When $^{203}HgCl_2$ was used as the test substance, it appeared that the following factors may influence the results: skin content of penetrated material, metabolism of the applied substance, subjectivity in the evaluation of the disappearance curves with minimal slope, applied volume, and lack of circulation. The dose rate from 7 μC ^{203}Hg at the skin surface was estimated at 1.5 rad/hr. (BBB)

32911 INFLUENCE OF PARA-AMINOSALICYLIC ACID ON THE ^{131}I METABOLISM. Munkner, Troels (Rigshospitalet, Copenhagen). Acta Radiol., Suppl. 234, 1-178(1965).

The effects of p-aminosalicylic acid (PAS) on iodine metabolism was elucidated by a systematic ^{131}I investigation in a group of PAS-patients. Normal iodine metabolism in man is summarized, and a survey was made of the known congenital or iatrogenic changes in the iodine metabolism. As a basis for an evaluation of the tracer data from PAS-patients, results of similar studies in patients with known thyroid disorders are included. These investigations were carried out during the same period and with the same technique as that applied in the PAS-patients. The only conclusion reached was that PAS-reagents excrete an iodine compound in their urine that is not identical with thyroxine, triiodothyronine or any other of the derivatives of iodothyronine. (368 references). (P.C.H.)

32912 INFLUENCE OF 5-HYDROXYTRYPTAMINE ON THE ABSORPTION OF TRITIATED WATER (HTO) FROM THE COLON OF THE RAT IN VIVO. Sewing, K.-Fr.; Winne, D.; Lembeck, F. (Univ., Tuebingen, Ger.). Arch. Exp. Pathol. Physiol., 252: 286-90(1965). (In German).

These experiments were designed to investigate the absorption of tritiated water from rat colon in vivo and the influence of 5-HT on this process. Adult male Wistar rats were narcotized with urethan and the proximal end of the colon canulated. The appearance of HTO in arterial blood was then followed after intracolonic injection of 0.5 ml of HTO (74.8 μC/ml) in 0.9% saline. In some rats the same dose of HTO was injected into the femoral artery. In other experiments, an infusion of 5-hydroxytryptamine (5-HT) was injected intravenously (0.1 ml/min, 50 μg 5-HT/ml) or a single injection of 5-HT (2.5 mg in 0.5 ml saline) was made into the colon. Results showed that the rate of HTO absorption from colon was only one-fifth of that from small intestine. Intravenous infusion of 5-HT (5 μg/min) reduced the rate of tritiated water absorption by about 50% whereas a single injection of 2.5 mg 5-HT into the lumen of the colon reduced the rate by only 25%. The volume of distribution of tritiated water was reduced by an intravenous infusion of 5-HT but not by its injection into the colon. The vasoconstriction caused by 5-HT may be responsible for its reduction of the distribution volume of HTO. (BBB)

32913 REGIONAL VARIATION OF ^{90}Sr CONTENT IN HUMAN DECIDUOUS INCISORS. Rosenthal, H. L.; Gilster, J. E.; Bird, J. T.; Pinto, P. V. C. (Washington Univ., St. Louis). Arch. Oral Biol., 11: 135-7(1966).

A comparison was made of the strontium-90 content of deciduous incisors of children born in other areas with the values obtained for St. Louis children to obtain an estimate of the diet strontium-90 during the time of tooth development. Tooth samples from children who were bottle fed from birth were obtained for five areas in a North-South transect between the eightieth and ninetieth meridian and for California. Strontium-90 content of teeth for children born between 1956-1958 in the northern hemisphere increases as the latitude decreases from Toronto to New Orleans. This relation follows the same general pattern for atmospheric radioactivity as determined by surface air sampling. Samples of teeth from children born in California contain ~50% less strontium-90 than teeth of St.

Louis children. Two samples of deciduous teeth of bottle-fed children born in Japan during 1956 contained 1.28 and 1.54 pC strontium 90/g calcium, values similar to that found in California. Furthermore, the deciduous teeth of German children and St. Louis children born during 1952–1954 contained comparable amounts of ^{90}Sr that averaged 0.45 pC/g Ca. The milk and diet strontium-90 values for New York, Chicago, and San Francisco are 2 : 1.5 : 1 respectively, which is in fair agreement with the estimations calculated from the equation $C_t = 0.59\ C_d$, where C_t and C_d represent tooth and diet levels of ^{90}Sr. These data suggest that the strontium-90 concentration in deciduous teeth represents an equilibrium function with the diet during the time the teeth are formed and that teeth may serve a useful purpose in indicating the dietary levels of strontium-90. (BBB)

32914 RETENTION OF RADIONUCLIDES BY THE ATLANTIC CROAKER MICROPOGON UNDULATUS. Baptist, John P. (Bureau of Commercial Fisheries, Beaufort, N. C.). ASB (Ass. Southeast. Biol.) Bull., 11: 39(Apr. 1964).

Whole-body retention of strontium-85, niobium-95, iron-59, cobalt-60, zinc-65, and indium-114 by croakers was determined following oral administration or intraperitoneal injection of each radioisotope. Retention of cobalt-60 was expressed as a single rate function representing a biological half life of 31 days. Retention of the other radionuclides tested was expressed as multiple rate functions consisting of two components. The long-lived component of strontium-85 had a biological half life of 138 days; niobium-95, 465 days; iron-59, 215 days; zinc-65, 138 days; and indium-114, 224 days. Comparisons were made between the biological half life and the effective half life of each radionuclide. (auth)

32915 APPLICATION OF DOUBLE ISOTOPE LABELING TO THE STUDY OF THE METABOLISM OF ASCITES TUMOR CELLS UNDER THE INFLUENCE OF GLYCERALDEHYDE. Wenzel, M.; Joel, I.; Oelkers, W. (Freie Univ., Berlin). Atomlight, No. 54, 1-6(June 1966).

A simple method for differential measurement of chromatograms bearing radioisotopes with different β-energies [$^3H/^{14}C$ or $^{14}C/^{32}P$] without changing the chromatograms in any way is described. The method is advantageous for the identification of unknown labeled metabolites such as amino acids from ascites cell extracts after incubation with ^3H-labeled precursors. The metabolic pathway of ^3H and ^{14}C from glucose-1-^3H and glucose-1-^{14}C to alanine and glutamic acid is identical under normal conditions and under the influence of glyceraldehyde. The inhibitory effect of L-glyceraldehyde on the formation of radioactive lactate from glucose-1-^3H or glucose-1-^{14}C is drastically increased by addition of inactive glucose. (auth)

32916 CHEMILUMINESCENCE DURING THE EFFECT OF FREE RADICALS ON NORMAL AND IRRADIATED YEAST CELLS. Petrusevich, Yu. M.; Konoplyannikov, A. G. (Lomonosov Univ., Obninsk, USSR). Biofizika, 10: 524-6(1965). (In Russian).

Oxidizing radicals, primarily atomic oxygen, were produced by the anodic oxidation of Na_2SO_4. Chemiluminescence from the action of the radicals on yeast cells was picked up on a photoelectric tube, amplified, and recorded. The chemiluminescence spectrum with a 440 mμ maximum was similar to the spectrum obtained from the oxidation of yeast cell lipids. The intensity depended linearly on number of yeast cells (up to 10-15 million/ml) and on the current strength. Cell inactivation was found to be negligible. The yeast cells (5 to 10 million/ml) were given ^{60}Co doses of 30, 60, and 90 krads which gave cell inactivations of 45, 90, and 100% respectively. The irradiated cells were placed in the electrolytic oxidation cell, and it was found that the chemiluminescence spectrum of the irradiated cells did not differ from that of the unirradiated yeast cells. (TTT)

32917 COUNTERACTION OF THE ANTIMITOTIC EFFECTS OF D_2O IN THE DIVIDING EGGS OF ARBACIA PUNCTULATA: A TEMPERATURE-PRESSURE ANALYSIS. Marsland, D.; Asterita, H. (New York Univ., New York, Marine Biological Lab., Woods Hole, Mass.). Exp. Cell Res., 42: 316-27(May 1966).

Early prophase eggs of the sea urchin, Arbacia punctulata, were immersed in 70% D_2O sea water at three different temperatures (15°, 20°, and 25°C) and then subjected to high pressure (1000 to 7000 psi). Subsequent counts as to the number of eggs that succeeded in the completion of the first cleavage division were made. These data formed a basis for analyzing the manner in which temperature influences the capacity of pressure to conteract the antimitotic effects of deuteration. Maximal release from mitotic blockage tended to decrease with increasing temperature, being 88% at 15°, 78% at 20°, and 71% at 25°C. The pressure required for maximal release was higher for the higher temperatures, being 3500 psi at 15° and 4500 psi at 20° and 25°C. Moreover, in the pressure range below these maxima, each increment of 5°C raised the pressure requirement for equivalent release by 500 to 1000 psi. The results are interpreted in terms of the effects of temperature, pressure and deuteration on the gel, or polymer, structure of the mitotic apparatus. Increasing temperature and deuteration tend to overstabilize this structure, whereas pressure tends to cause solation, or labilization. Thus pressure can counteract both the effects of temperature and deuteration by shifting the sol-gel equilibrium back into the range wherein mitotic function can continue. (auth)

32918 EFFECT OF PHOSPHORUS ON THE CONSUMPTION OF RADIOSTRONTIUM. Malkin, P. M.; Dubrovina, Z. V. Gig. Sanit., No. 12, 92-3(1965). (In Russian).

The effects of phosphorous additions in the diet on the absorption of ^{90}Sr by the body was investigated by giving white rats 1.2×10^{-9} Curies of ^{90}Sr per day along with phosphorous additions to diets that were low in calcium (2-3 mg Ca/day) and high in calcium (25 mg Ca/day). The amount of phosphorous had no effect on the ^{90}Sr uptake. The low-calcium diet showed a higher ^{90}Sr uptake of about 82% compared to 31% uptake of ^{90}Sr in the high-calcium diet. The Ca/P ratio was then varied by a factor of 13 on a low-calcium diet, but the amount of phosphorous still had no substantial effect on the absorption of ^{90}Sr from the stomach. Phosphorous additions to the diet also showed no effect on the ^{90}Sr absorption with a high-calcium diet in young and grown rats. (TTT)

32919 SOME ASPECTS OF METABOLISM AND TISSUE DOSIMETRY OF ^{226}Ra. Malykhin, V. M.; Shamov, V. P.; Reznik, G. S. (Inst. of Radiation Protection, Leningrad). Med. Radiol., 11: No. 5, 35-8(May 1966). (In Russian).

Build-up and dose parameters of ^{226}Ra were calculated on the basis of Marinelli's law, presenting the results in a graphic form. It was found that the maximum permissible concentrations derived differed from those reported by the ICRP by a factor of about 10. For the calculations, it was assumed that the Ra was built up at a constant rate during a limited period of contact, t_1. The period t_2 is calculated from the start of contact until the saturation dose is reached or ^{226}Ra is found in the excretion. Graphs are presented indicating the effect of buildup on the bony tissue as a function of various contact periods as t_1 varies from 1 to 50 years. Other diagrams allow estimation of the dose from the directly measured ^{226}Ra content in the organism or in the daily excretions. The higher MPC values are due to the fact that the buildup occurs more slowly according to the gradual model, in comparison with the exponential one. The tissue dose data presented represent a suitable starting point for additional studies on the effects of Ra on the human organism. (TTT)

32920 METABOLIC DISSOCIATION OF THE PARENT AND DAUGHTER RADIONUCLIDE PAIR, ^{140}Ba AND ^{140}La. Rama Sastry, B. V. (Vanderbilt Univ., Nashville). Nature, 210: 1395-6(June 25, 1966).

The physical decay patterns of barium-140–lanthanum-140 excreted in the urine in the first 4 days, and ^{140}Ba–^{140}La

accumulated by rat tissues (bone, kidney, and blood) in 4 days after intraperitoneal administration of ^{140}Ba-^{140}La were determined to evaluate the metabolic dissociation of the parent and daughter radionuclides in vivo. The results indicated that although Ba and La occupy adjacent positions in the periodic table and resemble each other in many of their physicochemical properties, some rat tissues show differential transport between ^{140}Ba and ^{140}La. (P.C.H.)

32921 CLIMATIC EFFECTS ON THYROID FUNCTION. SEASONAL VARIATIONS OF ^{131}I UPTAKE AND BIOLOGICAL HALF LIFE IN THE RABBIT THYROID. Uematsu, M. Nippon Gaibunpi Gakkai Zasshi, 40: 281-9(July 20, 1964). (In Japanese).

Thyroid ^{131}I uptake and biological half life in adult rabbits were determined from August 1960 to November 1961 (16 months). A dose of 10 μC carrier-free ^{131}I was injected subcutaneously in 2-kg rabbits, and beginning 24 hr after injection, thyroid radioactivity was measured daily for 5 days with a scintillation counter. The results of thyroid ^{131}I incorporating in 176 rabbits (about 10 rabbits/month) are given. The average 24-hr ^{131}I uptake for each month was: August 19.7%, September 14.3%, October 18.0%, November 24.0%, and December 27.7%. It then gradually decreased from January (20.6%) to June (10.3%) and increased again during summer (July 12.9%, August 21.2%) and thereafter (September 14.4%, October 20.0%, November 22.3%). The biological half life of ^{131}I was for August 1.10 days, September 1.27 days, October 2.24 days, and November 4.40 days. During winter it fell to 1.46 days in December, and in January increased to 2.04 days. It then decreased from March (1.85 days) to June (1.17 days), increased slightly in July (1.81 days), and decreased in August (1.01 days). The results show that the biological half life of ^{131}I was increased in November and July but decreased in the coldest weather and hottest weather. Thus the iodine uptake and release by the thyroid gland are promoted during the cold of winter and heat of summer. (BBB)

32922 EXPERIMENTAL STUDIES ON THE EXCRETION OF RADIOACTIVE STRONTIUM. Ogawa, Eiichi; Fukuda, Ryuzo; Suzuki, Shiro (Gunma Univ., Maebashi, Japan). Nippon Yakurigaku Zasshi, 57: No. 2, 29(1961). (In Japanese).

The effect of some drugs on excretion of ^{90}Sr was studied in 20-g male mice. They were placed individually in metabolic cages and injected with 1 μC ^{90}Sr. Each substance to be tested was administered daily for 3 days, and the excretion of ^{90}Sr in urine and feces was determined daily during this period. The animals were sacrificed 3 days after injection, and ^{90}Sr in bone was determined with a G-M counter. The influence of inorganic salts was tested first. The administration of $MgCl_2$ (5 mg/mouse/day), $Na_2S_2O_3$ (8 mg and 16 mg/mouse/day), and Na_2SO_4 (6.4 mg/mouse/day) significantly increased excretion of ^{90}Sr; NH_4Cl (1.8 mg/mouse/day) increased urinary excretion of ^{90}Sr, while $MgCl_2$ (2.5 mg/mouse/day) had no effect on the excretion of ^{90}Sr. The effect of chelating agents was also examined. Na Ca citrate (Na Ca citrate/Na_3 citrate = 0.5, as Na citrate 13 mM/kg), Na Mg citrate (Na Mg citrate/Na_3 citrate = 0.5 and 2.0 as Na citrate 13 mM/kg) reduced ^{90}Sr content of bone. Na Ca citrate (Na Ca citrate/Na_3 citrate = 2.0, as Na citrate 13 mM/kg), Na Pb citrate (Pb acetate/Na citrate = 0.2, 40 mg/kg and 20 mg/kg), Ca EDTA (50 mg/kg), Na EDTA (100 mg/kg), and Na tricarballylate (8.5 mM/kg) did not change the excretion of ^{90}Sr and its storage in bone. Achromycin (1, 2, or 4 mg/mouse/day) and tetracycline (1 mg/mouse/day) increased urinary excretion of ^{90}Sr but did not decrease ^{90}Sr storage in bone. (BBB)

32923 RELATIONSHIP BETWEEN THYROIDAL IODIDE TRANSPORT, BIOGENESIS OF THE THYROID HORMONES, AND DIFFERENT FAT AND IODINE INTAKES IN RATS. Stolc, V.; Langer, P.; Macho, L.; Kutka, M.; Knopp, J. (Inst. of Endocrinology, Bratislava). Physiol. Bohemoslov., 13: 351-7(1964).

Thyroid ^{131}I-iodide uptake and formation of ^{131}I-thyroglobulin (Tg), monoiodotyrosine (MIT), diiodotyrosine (DIT), thyroxine (T4), and triiodothyronine (T3) were examined in animals fed high and moderate fatty diets. Rats were fed 90 days on a diet containing 67% or 14% lard. The daily iodine intake was 0.75 or 2.15 μg/rat. It was found that fat did not affect the ^{131}I-iodide concentration in the thyroid, but stimulated the incorporation of ^{131}I into thyroglobulin. This led to an increase in the Tg/I quotient in the thyroid. It also lowered the percentage of T4, and T3 in the thyroid and raised the MIT/DIT quotient. An increase in the iodine intake did not affect the rate of ^{131}I-thyroglobulin synthesis. The percentage proportion of T4 and T3 in the thyroid was lowered. It was concluded that a high fat intake has an inhibitory effect on thyroid function. (BBB)

32924 COMPARISON OF ^{137}Cs BINDING CHARACTERISTICS IN PANGOLA HAY AND SPANISH MOSS. Elder, Robert L.; Moore, Wellington Jr. (Southeastern Radiological Health Lab., Montgomery, Ala.). Radiol. Health Data, 6: 586-9(Oct. 1965).

The Public Health Service Pasteurized Milk Network consistently reported higher concentrations of ^{137}Cs in milk from Tampa, Fla., than the national average. The ^{137}Cs contents in Pangola hay and Spanish moss were higher than in other plants in the Tampa area. The major portion of ^{137}Cs in plants is taken up through the leaves and Spanish moss is a non-rooted plant that obtains all of its nutritional requirements by direct surface absorption. A comparison of the binding and release of ^{137}Cs in Spanish moss and Pangola hay showed that ^{137}Cs was a surface contaminant of Pangola hay while Spanish moss actively binds and retains ^{137}Cs, as well as other airborne radioactive isotopes. Elimination of Pangola hay from the diet of dairy cows in the Tampa area resulted in a decrease in the content of ^{137}Cs in milk from the area. (C.H.)

32925 ^{45}Ca AND ^{89}Sr MOVEMENT IN SOILS, AND UPTAKE BY BARLEY PLANTS AS AFFECTED BY $Ca(Ac)_2$ AND $Sr(Ac)_2$ TREATMENT OF THE SOIL. Fuller, W. H.; Hardcastle, J. E.; Hannapel, R. J.; Bosma, Shirley (Univ. of Arizona, Tucson). Contract AT(11-1)-947. Soil Sci., 101: 472-84(June 1966).

Calcium and strontium acetate were found to substantially effect the movement of contaminating radiostrontium in calcareous, acid, organic, and gypsiferous soils. The extent of the movement varied with soil on the basis of equal volumes of soil in 7-inch columns. The rate of movement of Sr-89 and Ca-45 for the six soils involved decreased in the following order: Mohave sandy loam (0 to 6 inches > Mohave gravel sandy loam (54 to 60 inches) ≈ Tucson sandy loam (0 to 6 inches) > Purgatory loam (0 to 6 inches) ≈ Protovine silt loam > Mt. Lemmon gravelly cobbly loam (0 to 6 inches). The cation-exchange capacity of the soils increased in the same order. Uptake by barley seedlings of the radiostrontium and radiocalcium remaining in the soil columns was found to correlate directly with the Na(Ac)-extractable (presumably exchangeable) radioelements. (auth)

32926 ELABORATION OF STRONTIUM AND VANADIUM METABOLISM THROUGH NUCLEAR TECHNIQUES. Strain, William H. (Univ. of Rochester, N. Y.); Danahy, Daniel T.; O'Reilly, Richard J.; Thomas, Martin R.; Wilson, Robert M.; Pories, Walter J. Trans. Amer. Nucl. Soc., 9: 71-2(June 1966).

32927 STEREOSPECIFIC INCORPORATION OF (-)5,7,4'-TRIHYDROXYFLAVANONE IN FLAVONOIDS AND ISOFLAVONE. Patschke, L.; Barz, W.; Grisebach, H. (Univ., Freiburg i. B.). Z. Naturforsch., 21b: 201-5 (Mar. 1966). (In German).

(±) 5,7,4'-Trihydroxyflavanone-5-glucoside-[2-^{14}C] was synthesized and the diastereoisomeric (+) and (-) glucosides were separated by paper chromatography. In buckwheat seedlings the incorporation rate of the (-) enantiomer into quercetin was 16 times higher and into cyanidin 3.6 times higher than that of the (+) compound. In chana seedlings (Cicer arietinum L.) the (-) compound was incorporated into biochanin A (5,7-dihydroxy-4'-methoxy-isofla-

vone) 14 times better than the (+) compound, whereas in agreement with earlier results the incorporation of both enantiomers into the formononetin (7-hydroxy-4′-methoxyisoflavone) was very low. The results proved the stereospecific incorporation of the naturally occurring (–)-2-S-5,7,4′-trihydroxyflavanone into flavonoids and isoflavonoids. The incorporation of the (+) enantiomer was probably due to a racemization of this compound via the chalcone. (auth)

32928 ACTION OF VARIOUS CHELATING AGENTS ON THE RENAL EXCRETION OF STRONTIUM AND CALCIUM. Schmid, A.; Zipf, K. (Univ., Munich). Zentralbl. Veterinaermed., 12: 558-62(Dec. 1965). (In German).

The action of various chelating tetracyclines on the renal excretion of strontium and calcium in the rat was studied. For 30 days the animals were fed a strontium-containing diet which at the end of this time gave a strontium level in bone ash of about 8% and a serum level of 5 to 6 mg%. The tetracylines were injected subcutaneously in doses of 20 mg/100 g. The excretion of strontium became maximum within 30 min, then declined, but was still high 180 min after injection of the antibiotic. Tetracycline, chlortetracycline, and oxytetracycline inhibited the renal elimination of strontium, but the excretion of calcium was increased by tetracycline and chlortetracycline, and inhibited by oxytetracycline. Of the antibiotics tested, only dimethylchlortetracycline increased the urinary excretion of both strontium and calcium. Comparison of the structural formulas showed that demethylation in the 6-position may produce this effect by increasing the polar character of the compound. (BBB)

32929 MOESSBAUER SPECTROSCOPY OF IRON PROTEINS. Moss, Thomas Henry. Ithaca, N. Y., Cornell Univ., 1965. 180p.

Thesis.

The Mössbauer spectra of a number of iron proteins and model compounds enriched to greater than 80% in ^{57}Fe were examined over the temperature range 2.5°-350°K. Using an off-set cam drive spectrometer, the enriched compounds gave intense absorption lines, which could be resolved to 0.01 mm/sec in many cases. The spectra of the model hemin chloride compounds showed a quadrupole splitting and isomer shift characteristics of highly ionic Fe(III). The very small differences between the spectra of the proto-, meso-, and 2,4-diacetyl deuterohemin chlorides show the comparative isolation of the iron from the porphyrin ring in the high-spin hemin chlorides. Mössbauer spectra of the hemin chlorides in acetone and glacial acetic acid are identical with those in the crystalline form. The Mössbauer spectra of the bis-pyridine heme compounds are characteristic of low spin Fe(II) in an asymmetric ligand field. The isomer shift measurement shows that effectively one d-electron is delocalized to the porphyrin ring π-orbital system. Because of the intimate connection between iron and ring orbitals the difference in electron withdrawing power between acetyl and ethyl ring substituents is clearly seen in the Mössbauer quadrupole splitting. A change to low-spin iron on lyophilizing metmyoglobin and methemoglobin is definitively demonstrated by the Mössbauer spectra. The data indicate that a second histidine residue becomes bound to the iron when the water is removed. The c-type cytochrome and the cytochromoid RHP from Chromatium are also shown to be low-spin compounds in buffered solution at 77°K. The spectra of chromatium ferredoxin and HiPIP show that two types of iron are present in these nonheme proteins. The two pairs of lines seen may indicate iron in two sites, but more likely is due to iron in two valence states. Mixed spin states are not present. A striking result of the Mössbauer experiments was that the iron in the proteins did not seem to be affected by oxidations and reductions which caused changes in the optical spectra. (TCO)

Radiation Effects on Biochemicals

See also CHEMISTRY — Radiation Chemistry

Refer also to abstracts 33031, 33384, 33393, and 33394.

32930 GRANULOCYTE DISTRIBUTION IN BONE MARROW, BLOOD, AND DIFFERENT ORGANS IN WHOLE-BODY-IRRADIATED RATS. Cederberg, Antti (Univ. of Helsinki). Acta Radiol., Suppl. 240, 1-94(1965).

Studies were made on quantitative changes in the granulocytes of the bone marrow, blood, and various tissues after 700-R whole-body irradiation during the first 9 days in the rat. As a result of irradiation there was an exponential fall in the nucleated cell count in the bone marrow until the third day, when the value 0.14×10^6/cu.mm was reached. The fall of the eosinophils and neutrophils was also exponential until the fourth day. The most important of the histological changes visible in the bone marrow was the total disappearance of the vascular architecture and, as a result of this, the so-called nonthrombopenic hemorrhage, which reached its maximum on the third postirradiation day. Cytological changes caused by irradiation were also observed in the blood cells. Changes in the lymph system, spleen, and lungs are also discussed. It was concluded that the granulocytes are of great importance in radiation damage as a general and local defense mechanism against endo- and exogenous noxa, especially in the gastrointestinal tract, irrespective of the status of the epithelial cells. (196 references). (P.C.H.)

32931 EFFECTS OF IONIZING RADIATION ON CREATINE METABOLISM IN PATIENTS TREATED FOR MALIGNANCY AND IN RATS. Kurohara, Samuel S. (Univ. of Rochester, N. Y.). Acta Radiol., Suppl. 244, 1-125(1965).

Determinations were made of the urinary creatine coefficient (creatine/creatinine ratio) and/or the daily urinary creatine and creatinine excretions, the plasma creatine and erythrocyte creatine concentrations, the eosinophil and leukocyte counts, the hematocrit and the body-weight in patients irradiated for malignant disease, in rats given partial-body roentgen irradiation and in rats given whole-body roentgen irradiation following thyroid or adrenal ablation. Differences in mean values among individuals in female or male subjects were significant for the blood creatine values but not for the creatine coefficient. Differences in the mean values among individual rats were significant for blood and urinary creatine values. The results indicated that the dose, time, and volume factors, used under the usual therapeutic schedule, are just below the threshold for creatinuric response of the male patients and just above that of the females. Other results are also discussed. (354 references). (P.C.H.)

32932 INTERACTION OF BLOOD SERA WITH A CULTURE OF PARAMECIUM CAUDATUM. II. INDIVIDUAL SENSITIVITY TO MEDIUM LETHAL X-RAY DOSES DETERMINED BY THE CONSUMPTION OF COMPLEMENT BY A CULTURE OF PARAMECIUM CAUDATUM. Cabadaj, Stanislav; Praslicka, Milan; Bernasovsky, Ivan (Safarik Univ., Kosice, Czechoslovakia). Biologia, 21: 3-9(1966).

A culture of Paramecium caudatum added to fresh rat or human blood serum inhibits hemolysis of sensitized sheep erythrocytes, i.e., it consumes the complement. The consumption of the complement is generally greater in healthy, nonirradiated rats than it is in the irradiated ones, but in both groups there are considerable individual differences. The prognostic significance of this interaction was investigated after an x-ray dose of 550 R. The minimum hemolytic dose (MHD) of complement in healthy, nonirradiated rats, and the number of MHD of the complement (NMHD) consumed by a culture of paramecium was determined by the complement consumption test with paramecium and by the titration of complement. Twenty-four hr after the test the rats were exposed to an x ray dose of 550 R, and then were followed with the tests for 30 days. Rats with high NMHD survived longer and in greater numbers than those with a lower NMHD. Likewise rats with a high MHD (low complement level) survived longer than those with a low MHD. The longest survival was observed in rats which had high values of both NMHD and MHD. (BBB)

32933 RADIATION-INDUCED PROTEIN LOSS INTO THE GASTROINTESTINAL TRACT. Vatistas, S.; Hornsey,

Shirley (Hammersmith Hospital, London). Brit. J. Radiol., 39: 547-50(July 1966).

The dose effect relationship for the leakage of molecules of plasma protein size, i.e., of polyvinyl pyrrolidone into the intestine, after single doses of x rays and neutrons and after fractionated doses of x rays was established. It is suggested that the relationship between this functional test of damage and the morphological damage induced in the intestinal epithelium is not close. (auth)

32934 LOCALIZATION OF FREE RADICALS INDUCED BY IONIZING RADIATION IN DESOXYRIBONUCLEIC ACID IN THE SOLID PHASE. van de Vorst, Albert; Krsmanovic-Simic, Draga (Univ., Liege). Compt. Rend., Ser. D, 262: 2288-90(May 23, 1966). (In French).

The evolution of the electron paramagnetic resonance spectra of DNA irradiated in the solid phase of ionizing radiation was studied as a function of dose. It was found that the radicals induced are located in guanine, cytosine, and thymine. Adenine was not directly detected. (tr-auth)

32935 CHEMICAL AND BIOLOGICAL EFFECTS OF ELASTIC NUCLEAR COLLISIONS. Jung, H.; Zimmer, K. G. (Kernforschungszentrum, Karlsruhe, Ger.). pp 69-127 of Current Topics in Radiation Research. Vol. II. Ebert, Michael; Howard, Alma (eds.). Amsterdam, North-Holland Publishing Company, 1966.

Chemical and biological effects of elastic nuclear collisions are reviewed, with emphasis on the importance of the elementary processes involved in elastic nuclear collisions. Aspects considered include: mechanisms of energy transfer in the absorption of radiation; physical properties of elastic nuclear collisions; nuclear stopping power for water and tissue; and the importance of experiments on the biological effectiveness of elastic nuclear collisions. Experiments on the chemical effectiveness of elastic nuclear collisions with polyethyleneterephthalate and the biological effectiveness of elastic nuclear collisions in ribonuclease are also discussed. The biological effectiveness of the various primary mechanisms is compared. Target theory is applied to experimental data with reference to the significance of the impact parameter. (103 references). (H.G.D.)

32936 MOLECULAR BASIS OF BIOLOGICAL EFFECTS OF ULTRAVIOLET RADIATION AND PHOTOREACTIVATION. Setlow, Jane K. (Oak Ridge National Lab., Tenn.). pp 195-248 of Current Topics in Radiation Research. Vol. II. Ebert, Michael; Howard, Alma (eds.). Amsterdam, North-Holland Publishing Company, 1966.

Biological effects of uv radiation in terms of specific changes in DNA are reviewed. The topics covered include: uv-induced physical and chemical changes in nucleic acid and nucleic acid components; correlation between observed changes in nucleic acid and biological effects; enzymatic repair of uv-induced lesions; effects of bromouracil or iodouracil substitution on uv killing; and uv-induced mutation and repair of premutational lesions. (206 references). (P.C.H.)

32937 SYNTHESIS OF DNA UPON IRRADIATION OF CYTOPLASM AND NUCLEUS OF HeLa CELLS WITH A MICRO-PENCIL OF α PARTICLES. Vainson, A. A.; Kuzin, A. M. (Inst. of Biological Physics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 165: 933-6 (Dec. 1, 1965). (In Russian).

The formation of radiotoxins was found to be a significant factor in depression of DNA synthesis by irradiation. The mechanism of the action may consist in both a decrease in enzyme activity in the later stages of DNA synthesis and direct damage to deoxyribonucleoprotein. The experiments were made with HeLa cells in a tissue culture, which were irradiated with a narrow beam of alpha particles (5.3 Mev) from a ^{210}Po source. With an absorbed dose of 1 to 2 krads, the rate of DNA synthesis decreased rapidly to 90 to 60% of normal, depending on the time after the irradiation and the cell structure irradiated. It then leveled off, remaining about the same for doses up to 8 krad. Irradiation of the cytoplasm required about 10 times more energy for the same effect as irradiation of the nucleus. However, in irradiation of the whole cell, probably the chemically active substances formed were more significant than was apparent because of certain experimental conditions. (TTT)

32938 TRANSFER OF ULTRAVIOLET-INDUCED EXCITATIONS IN SOLID PROTEINS. Rosen, C.-G. (Royal Univ., Stockholm). pp 137-42 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

The migration of excitation energy between chromophores in a macromolecule was measured directly in order to elucidate the influence of adsorbed water on energy transfer in biological processes. Thin transparent films of 1-dimethylaminonaphthalene-5-sulfonyl conjugated bovine serum albumin containing H_2O contents of 2–30% were irradiated with uv radiation, and the absorption and fluorescence spectra were recorded alternatively. The varying water content had no drastic effect on excitation transfer in this system, and the principal effect of the adsorbed water was to increase the intramolecular distances, causing swelling of the macromolecule. (B.L.M.)

32939 EFFECT OF METAL IONS UPON THE RADIATION DAMAGE IN PROTEINS. Hunt, J. W. (Ontario Cancer Inst., Toronto); Robins, A. B. pp 143-52 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

The results are reported of a study to investigate the protective properties of metallic complexes for proteins against radiation damage and to study the yield of stable free radicals produced by the irradiation of trypsin and ribonuclease (RNase). Complexes of the metallic ions and proteins were studied in both the freeze-dried and solution conditions. The protection by a wide range of metallic ions was investigated, and it was found that Cu^{2+}, Fe^{2+}, Mn^{2+}, and Co^{2+} ions all protect RNase against activation and reduce the free-radical yield. Conversely, Zn^{2+} neither protected nor reduced the free-radical yield. Without exception, a reduced free-radical yield and reduced radiation sensitivity always occurred for the same metallic ions. Parallel behavior was not always noted for the two proteins examined. Three possible interpretations of the data as to energy transfer mechanisms are presented. (B.L.M.)

32940 REACTIVITY TRANSFER IN A MODEL BIOLOGICAL SYSTEM. Singh, B. B.; Charlesby, A. (Royal Military Coll. of Science, Shrivenham, Eng.). pp 165-72 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

E.s.r. spectra and thermoluminescence and uv phosphorescence measurements are reported for γ-irradiated samples of adenine, adenosine, adenylic acids (2′, 3′, or 5′-phosphate), polyadenylic acid, and D-ribose. A current literature survey of similar work on other related compounds is included. The radioprotective effects of cysteamine on these compounds are also reported. Interpretation of the data for simple proteins in terms of reactivity transfer in a biological system is presented. (B.L.M.)

32941 RADIATION INACTIVATION OF PURIFIED LYSINE VASOPRESSIN. Odell, W. D.; Swain, R. W.; Bowers, C. Y.; Schally, A. V. (National Cancer Inst., Bethesda, Md. Tulane Univ., New Orleans). Experientia, 22: 342-4(May 15, 1966).

Lysine vasopressin is a polypeptide hormone which is available in completely pure form. When lysine vasopressin was exposed to ionizing radiation in air or in argon atmosphere loss of biological activity was observed. The data were used to estimate the molecular weight. Amino acid analyses were performed on identical aliquots of lysine vasopressin subjected to high and low doses of radiation. Destruction of amino acids occurred at both 2.50×10^8 rads and 10.0×10^8 rads. Data from amino acid analyses are presented. (C.H.)

32942 EFFECTS OF RADIATION ON DNA SYNTHESIS IN THE LIVER AND INTESTINES, GIVEN AT TWO DIFFERENT DOSE RATES. Looney, W. B. (Univ. of Vir-

ginia, Charlottesville). Int. J. Radiat. Biol., 10: 97-102 (Feb. 3, 1966). (TID-22052).

Two series of experiments were carried out with male rats to determine the relative depression of DNA synthesis at dose-rates of 300 R/min ranging from 375 to 24,000 R, and at 12.5 R/min ranging from 11.8 to 1500 R. Values for depression in DNA synthesis in liver and intestines are given for the different doses. The results suggest that total radiation dose alone is inadequate for the proper assessment of the effects of radiation in DNA-synthesis. (P.C.H.)

32943 EFFECT OF 2000 r OF X RAYS ON THE ACID AND ALKALINE PHOSPHATASE OF MOUSE TIBIAE. Sams, Alice (Westminster Hospital, London). Int. J. Radiat. Biol., 10: 123-40(Feb. 28, 1966).

The effect of 2000 R of 200 kvp x rays on the acid and alkaline-phosphatase content of mouse tibiae up to 80 weeks after irradiation is described. The enzymes were demonstrated histochemically using the coupling azo dye method. The alkaline phosphatase content was diminished within 24 hours after irradiation, due mainly to the loss of mesenchymal cells from the metaphysis and the disorganization of the epiphyseal plate. The amount of enzyme present further diminished with time compared with controls, except where nests of apparently normal cartilage cells appeared in the epiphyseal plate. These eventually gave rise to a new epiphyseal plate that was relatively normal in structure and enzyme content. The articular cartilage cells contained apparently normal amounts of alkaline phosphatase throughout the period of observation and the periosteum and endosteum made good recovery. The acid phosphatase content was not so markedly affected by irradiation. After an initial transient increase there was a reduction in the acid phosphatase content compared with the control except in tibiae where a new epiphyseal plate was being formed or in areas of necrotic bone where there were increased amounts of enzyme. (auth)

32944 STUDIES ON DETOXIFICATION IN THE ISOLATED PERFUSED LIVER. III. SYNTHESIS AND CONJUGATION OF BILE ACIDS. Gerber, G. B.; Remy-Defraigne, J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Contract 053-64-3-BIO. Int. J. Radiat. Biol., 10: 141-9(Feb. 28, 1966).

Conjugation and excretion of bile acids and metabolism of taurine ^{35}S were studied in the isolated perfused liver from normal and x-irradiated rats. More bile acids are present and more were synthesized after irradiation. Taurine was removed more rapidly by the irradiated liver if no bile acids were added. No difference existed between normal and irradiated liver with respect to conversion of deoxycholate to cholate, conjugation of bile acids and the general excretion pattern of bile steroids and phospholipids. (auth)

32945 DNA SYNTHESIS IN IRRADIATED LYMPHOID CELLS: EFFECTS OF TEMPERATURE ON THE DOSE-RESPONSE CURVE. Manasek, F. J.; Adelstein, S. J.; Lyman, C. P. (Harvard Univ., Boston). Int. J. Radiat. Biol., 10: 189-97(Feb. 28, 1966).

The effects of x rays on DNA synthesis in suspensions of hamster spleen cells were studied. The nature of the dose-response curve was found to be dependent on two factors: the temperature at which the cells were irradiated and the temperature at which they were incubated with tritiated thymidine. Irradiation at 37°C and incubation at 37°C results in a monophasic semilogarithmic dose-response curve with a D37 per cent of 7 krads. Irradiation at 7°C with incubation at 37°C results in a biphasic dose-response relationship with the initial steep part of the curve having a D37 per cent of 4 krads and the shallow part a D37 per cent of 28 krads. 20°C irradiation followed by incubation at 37°C results in a biphasic curve with a steep portion having a D37 percent of 4 krads and a shallow portion with a D37 per cent of 28 krads. Lowering the irradiation temperature to 7°C and incubating the irradiated cells at 17°C results in a monophasic response with a D37 per cent of about 20 krads, whereas irradiation at 37°C and incubation at 17°C yields a biphasic curve. The implication of these findings with respect to the nature of the radiation damage is discussed. (auth)

32946 URINARY EXCRETION OF 5-HYDROXYTRYPTAMINE AND 5-HYDROXYINDOLEACETIC ACID IN RELATION WITH THE SURVIVAL TIME OF X-IRRADIATED RATS. Deanovic, Z.; Supek, Z. (Institut Rudjer Boskovic, Zagreb). Int. J. Radiat. Biol., 10: 199-202 (Feb. 28, 1966).

Determinations of urinary 5-hydroxytryptamine (5-HT) and 5-hydroxy indoleacetic acid (5-HIAA) in x-irradiated rats (665 R) were performed. No significant association between the excretion of 5-HT and survival time was found. However, the amounts of excreted 5-HIAA after irradiation, as well as the sum of 5-HT and 5-HIAA, gave a significant positive correlation with the survival-time. It seems that an intensive radiation-induced liberation of 5-HT, with its prompt degradation and excretion, might have a favorable influence on the fate of sub-lethally irradiated animals. (auth)

32947 EFFECT OF ULTRAVIOLET LIGHT AND THIOL COMPOUNDS ON GUINEA PIG SKIN HISTIDASE. Anglin, J. Hill Jr.; Jones, David H.; Bever, Arley T.; Everett, Mark Allen (Univ. of Oklahoma, Oklahoma City). J. Invest. Dermatol., 46: 34-9(Jan. 1966).

Total urocanic acid (UCA) content of skin is decreased in quantity after uv irradiation in vivo. Trans-UCA, the isomer normally present in skin, is also partially converted to the isomeric cis form. Experiments were undertaken to determine if there was a uv effect on the enzyme forming UCA from L-histidine in the skin. This enzyme, histidase, deammoniates L-histidine-2-^{14}C, producing UCA in guinea pig epidermal homogenates. Histidase activity is present in epidermis but not dermis, while urocanase normally present in liver is absent in skin. Thus, in skin, the degradation of L-histidine occurs after deammoniation and UCA accumulates. It was found that uv irradiation of guinea pig skin in vivo produces an increase in epidermal histidase activity, but irradiation in vitro does not. Independent of the uv irradiation effect, glutathione (GSH) and several other thiols increased the rate of enzyme activity. L-cysteine decreased the activity. An optimum GSH concentration was shown above which the activity is decreased. Since UCA constitutes about 80% of the uv absorbancy of dilute acid epidermal extracts, UCA may serve to protect the deeper layers of the skin from the harmful effects of uv rays striking the epidermis. The function of histidase in skin may be to maintain a fixed level of UCA, since it appears that the UCA present is formed entirely by the enzymatic deammoniation of histidine. The initial increased histidase activity following uv exposure tends to minimize the decrease in UCA observed. (BBB)

32948 DEGRADATION OF RIBONUCLEIC ACID IN DILUTE SOLUTION BY IONIZING RADIATION. Pollard, E. C. (Pennsylvania State Univ., University Park). Nature, 210: 1393-5(June 25, 1966).

The radioinduced degradation of RNA in dilute solution was observed, and the number of breaks produced in a unit of molecular weight 10^6 were estimated by comparison with the thermally induced scission of RNA. Four concentrations of RNA, 2, 1, 0.5, and 0.25 mg/ml, were exposed to radiation from a ^{60}Co source delivering 5,500 R/min. The number of breaks produced in a unit of 10^6 molecular weight per 100 ev energy released, the G-value of radiation chemistry, was found to be 0.8 ± 0.1. Similar experiments on DNA gave a G-value for a break that was less by about a factor of two. The behavior of double-stranded DNA was somewhat different. (P.C.H.)

32949 KINETICS OF ENZYME INACTIVATION IN SOLUTION BY IONIZING RADIATION. ley, Niels (Norsk Hydro's Inst. for Cancer Researc. Oslo. Univ. of Copenhagen). Naturwissenschaften, 53: 276(1966).

Kinetic equations for enzyme inactivation in dilute aque-

ous solutions were solved without the simplifying assumptions previously used. All five rate constants of the theory may be deduced from experimental data. The case when the enzyme E is predominately inactivated by one free radical X formed in the water by irradiation is illustrated. The use of the kinetic equations for elucidating the basic mechanisms of the effects of protecting and sensitizing substances is discussed. (J.S.R.)

32950 FORMATION OF A CYCLONUCLEOTIDE BY X IRRADIATION OF ADENOSINE MONOPHOSPHATE. Keck, K. (Univ., Freiburg i. B.); Hagen, U.; Friebolin, H. Naturwissenschaften, 53: 304-5(June 1966). (In German).

Aqueous solutions of adenosine monophosphate (5×10^{-3} M) at pH 7 were irradiated with x or γ rays under nitrogen. By chromatography on diethylaminoethyl cellulose a substance could be isolated which varies slightly in its chromatographic, electrophoretic, and uv spectroscopic properties from the initial compound. The compound possesses the structure of a cyclonucleotide with a new bond between the C_8 of the adenine and the ribose. (J.S.R.)

32951 PHYSICAL CHARACTERISTICS OF THE RESIDUAL DNA IN BACTERIAL CELLS AFTER DEGRADATION DUE TO IONIZING RADIATION. Pollard, Ernest; Swez, John; Grady, Leo (Pennsylvania State Univ., University Park). Radiat. Res., 28: 585-96(July 1966).

Gamma-radioinduced degradation of residual DNA in E. coli showed that the residual DNA has approximately the same temperature-dependent hyperchromicity and the same buoyant density as normal DNA and changes buoyant density on heating and rapid cooling in the same way as does normal DNA. It was concluded that the residual DNA is double-stranded and therefore that the difference in radiosensitivity is not due to one strand having more sensitivity than the other. (P.C.H.)

32952 SYSTEMIC FACTOR IN RECOVERY OF RAT KIDNEY FROM X IRRADIATION: THYMIDINE-^{3}H INCORPORATION STUDIES. Wachtel, L. W.; Phillips, T. L.; Cole, L. J. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 28: 647-56(July 1966).

The effects of x irradiation on thymidine-^{3}H incorporation into kidney cells (thymidine index) was measured at 4- to 8-hour intervals up to 96 hours in unilaterally nephrectomized female weanling rats. A sharp drop in the thymidine index occurred during the first 16 hours after the kidney only was irradiated with 1000 rads, and also after the kidney was irradiated with 125 rads or 500 rads at the same time the body received 500 rads. Irradiation of the body, but with the kidney completely shielded, had no apparent inhibitory effect on kidney thymidine incorporation. The ability of the irradiated kidney to incorporate thymidine reappeared in 24 hours if the remainder of the body was not irradiated. When both the body and the kidney were irradiated, recovery of thymidine uptake depended on the amount of radiation received by each. An explanation for the results is offered on the basis of a postulated systemic factor, the formation or induction of which could be affected by radiation and which is essential for thymidine incorporation in the kidney. (auth)

32953 TEMPERATURE DEPENDENCE OF IONIZING RADIATION EFFECT ON DRY LYSOZYME AND RIBONUCLEASE. Fluke, Donald J. (Duke Univ., Durham, N. C. Florida State Univ., Tallahassee). Radiat. Res., 28: 677-93(July 1966).

Dry films prepared from water solutions of lysozyme and ribonuclease A were irradiated in a vacuum with 3-Mev electrons. Sample temperatures were controlled within 2 to 3 degrees in the range 93 to 455°K. Preparations irradiated at various temperatures were brought to ambient, exposed to air, redissolved in appropriate buffers, and assayed for remaining enzymatic activity. Activities were corrected for recovered soluble protein according to buret response. The two enzymes, similar in molecular weight, showed significant differences in temperature dependence of the inactivation, represented as a sum of terms differing in activation energy. Previous suggestion of an activation energy in common at room temperature and above for ultraviolet and ionizing radiations on enzymes was contradicted by the result for ribonuclease, and estimates of a middle-term activation energy less than kT are revised upward. (auth)

32954 COMPARISON OF GAMMA-RADIATION EFFECTS ON SOLID ATP-CREATINE PHOSPHOTRANSFERASE AND GELATIN. Friedberg, Felix; Hayden, George A. (Howard Univ. Coll. of Medicine, Washington, D. C.). Radiat. Res., 28: 717-25(July 1966).

When ATP-creatine phosphotransferase was irradiated by γ rays in an evacuated solid state, intrinsic viscosity increased and number average molecular weight remained constant. While some covalent damage occurred when the globular enzyme was irradiated, there was early apparent macromolecular conformational change. Splitting of the parent molecule into smaller units was not evident. When gelatin, which in solution exists in the form of random coils, was irradiated in the evacuated solid state and then placed into solution, it exhibited lower intrinsic viscosity and lower average molecular weights as the result of degradation on exposure to the γ irradiation. Covalent addition of sulfhydryl or tyrosyl groups to the gelatin molecule did not reduce its radiosensitivity. (auth)

32955 EFFECTS OF γ RADIATION ON THE CONTENT OF CARBOHYDRATES IN COTTON SEEDS. Ibragimov, A. P.; Marfina, K. G. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). (Uzb. Biol. Zh., No. 2, 7-11 (1966). (In Russian).

As a result of the radiation of cotton seeds, it was established that doses of 1000 to 3000 R are optimum for development of cotton variety 108-pH and acceleration of carbohydrate synthesis. Presowing irradiation of seeds with γ rays at doses of 6000 to 10,000 R accelerated the germination of the plants and increased the synthesis of carbohydrates only in the first period of ontogeny. Presowing irradiation of seeds caused a stimulating effect on the synthesis of carbohydrates; the stimulating effect was maintained in the descendants. At high irradiation doses the disaccharides were decomposed with the formation of fructoses and glucoses. (tr-auth)

32956 EFFECT OF GENERAL IRRADIATION BY γ RAYS FROM ^{60}Co ON THE AMOUNT OF CARBOHYDRATE-PHOSPHORUS METABOLISM IN CARDIAC AND SKELETAL MUSCLES. Lobanova, N. M. Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk, No. 1, 53-8(1963). (In Belorussian).

The effects of a whole-body single irradiation with ^{60}Co γ rays on the concentration of the intermediary products of the carbohydrate-phosphorus exchange in cardiac and skeletal muscles were investigated. On the basis of experimental data, the changes that occur in the violation of the quantitative ratio between intermediary products of the carbohydrate-phosphorus exchange in the cardiac and skeletal muscles in the irradiated animals were established. (tr-auth)

32957 COMPARATIVE PHOTOREACTIVATION OF ULTRAVIOLET LIGHT-INACTIVATED TOBACCO MOSAIC VIRUS RIBONUCLEIC ACID ON CHENOPODIUM, PINTO BEAN, AND TOBACCO PLANTS. Werbin, H.; Hidalgo-Salvatierra, O.; Seear, J.; McLaren, A. D. (Univ. of California, Berkeley). Virology, 28: 202-7(Feb. 1966).

The successful isolation and purification of a photoenzyme from yeast which can monomerize some of the lesions (thymine dimers) induced by uv irradiation of Haemophilus influenzae-transforming DNA suggested that there may be an enzyme acting similarly in tobacco leaves which partially reactivates, in the presence of visible light, uv-irradiated tobacco mosaic virus nucleic acid (TMV-RNA). TMV-RNA inactivated in uv light (2537 Å) was photoreactivated on leaves of Chenopodium, Pinto bean, and tobacco. There was greater photoreactivation on tobacco leaves than on the leaves of the other two plants. The quantum yield for the inactivation of the nucleic acid was about the same regardless of which plant was used as host when leaves were infected and left in the dark. This

finding indicates the lack of dark recovery mechanisms in plant leaves for repair of TMV-RNA inactivated at 2537 Å. Illuminated leaves had higher temperatures than leaves left in the dark. This temperature difference did not influence the extent of photoreactivation, nor did the presence of bentonite in the inoculum. (BBB)

32958 ANTIBODIES TO X-IRRADIATED RABBIT TISSUE. Hook, William Arthur. College Park, Univ. of Maryland, 1965. 157p.

Thesis.

Studies were performed to determine whether rabbits would produce antibodies against their own tissue as a consequence of exposure to ionizing radiation. Antigens were extracted from saline homogenates of testes obtained 2, 10 or 42 days after exposure to a 2000-R dose of x rays. Heterologous rat, isologous rabbit, and autologous rabbit testes antigens, in combination with adjuvant, were used to immunize rabbits. Titration of antigens and antiserums revealed that 10- and 42-day post-2000-R antigens were serologically less reactive and less anticomplementary than antigens from 2-day post-2000-R or nonirradiated testes. Antigens from irradiated, isologous, and autologous rabbit testes appeared less immunogenic than nonirradiated testes. No evidence was obtained to indicate that new antigenic characteristics occurred in irradiated tissue. All rat testes antigens were highly immunogenic for rabbits. Isologous rabbit testes evoked much lower antibody titers, and autologous rabbit testes antigens were the least active immunizing agents. Naturally occurring antibody of rabbit serum reactive with rabbit testes antigen was found to be associated with relatively high molecular weight beta-globulins resembling the 19S type. Antigens were compared for differences in chemical constituents and electrophoretic behavior. Rabbit testes antigens were used to follow natural antibody levels in rabbits given 500 R whole-body or 2000 R testes irradiation. Whole-body-irradiated rabbits exhibited a decline in natural antibody titer which, in some cases, was followed by a rise to above pre-irradiation levels. It was concluded that the appearance of elevated natural antibody titers following whole-body radiation probably did not represent true autoantibody production caused by x-ray damage to tissue. No important changes were seen in natural antibody levels of rabbits given testes-only irradiation. It was concluded that radiation damage to the testes or entire body of rabbits probably did not induce autoantibody formation. (TCO)

32959 CHANGES IN ADSORPTION PROPERTIES OF SERUM PROTEINS UNDER THE ACTION OF DIFFERENT DOSES OF IONIZING RADIATION ON AN ORGANISM. Frenkel, L. A. pp 369-92 of Sb. Voprosy Biofiziki i Mehanisma Deistviya Ioniziruyushchei Radiatsii. Kiev, Zdorovya, 1964. (In Russian).

Rabbits were exposed to a single whole-body x-irradiation dose of 800, 1500, or 3000 R. After 5 min and after 1, 2, 4, 7, 10, 20, and 30 days postirradiation blood samples were taken from the ear vein to study the adsorption properties of the serum protein. Changes in the temperature dependence of the electrical conductivity of protein solutions were measured at high frequency current by the author's method. It was found that in first 5 min after radiation exposure the desorption and dissociation of the serum proteins are increased; with an augmentation of the dose the rate of this increase begins to decrease. The same results were seen 1-day after exposure. Later the results appeared more complicated. Altogether, the period of development of the abnormal adsorption phenomenon correlated with the max death rate. The amelioration in the animals' condition was preceded by a transition to increased dissociation and desorption in the proteins. The usefulness of this method in detecting changes in the structure of serum proteins in irradiated animals is emphasized. (BBB)

32960 THE CONCENTRATION OF THE USUAL PROTEIN FRACTIONS AND LOW-MOLECULAR-WEIGHT PROTEINS IN THE SERUM OF RATS EXPOSED TO THE ACTION OF BREMSSTRAHLUNG FROM 3.5 Mev ELECTRONS FROM A LINEAR ACCELERATOR. Mamotyuk, E. M. pp 11-14 of Sb. Voprosy Eksperim. i Klinich. Radiologii, Vyp. I. Kiev, Zdorovya, 1965. (In Russian).

Experiments were carried out to test the influence on rats of the bremsstrahlung from electrons accelerated at 3.5 Mev in doses of 270 and 600 R. It was found that the total protein content in the serum of rats after irradiation with 270 R changed very little. After an exposure of 600 R the total protein content in serum after 1 min and 6 hr increased (to ~7.2%), then by 24 and 48 hr decreased. On the 3rd day it increased again and after 10 days it decreased (to 5.29%). The content of low-molecular-weight proteins in early stages of the development of the radiation sickness changed in parallel with that of other proteins. In the period from two to 30 days postirradiation the content of low-molecular-weight proteins increased considerably. It is concluded that this is related to the increase of mucoprotein content of serum. (BBB)

32961 HISTOCHEMICAL CHANGES IN DEOXYRIBONUCLEOPROTEINS OF THE CORNEA AFTER THE EXPOSURE OF EYES TO SOFT X RAYS AND β RAYS. Marmur, R. K.; Korotaieva, L. F. pp 120-3 of Sb. Voprosy Eksperim. i Klinch. Radiologii, Vyp. I. Kiev, Zdorovya, 1965. (In Russian).

The exposure of rabbits' eyes to soft x rays (6000 R) or to ^{90}Sr β rays caused changes in the contents and in the structure of the deoxyribonucleoproteins in the cornea. X irradiation caused a marked decrease in the deoxyribonucleoprotein content as early as 24 hr post-irradiation. Within 3 days a modification of the structure of nucleoprotein occurs which attains max development after a week The changes in nucleoprotein of the cornea caused by ^{90}Sr β rays have the same appearances as after x irradiation, but are more intense. Within three to 20 months after exposure a partial normalization of the deoxyribonucleoproteins in the cornea was noted. (BBB)

Radiation Effects on Tissues

Refer also to abstracts 32907–32909.

32962 (AD–627686, pp 423-33) SPACE RADIOBIOLOGY TRAINING AND OPERATIONS—A CONCEPT. Pickering, John E. (Aerospace Medical Div., Brooks AFB, Tex.).

The contribution of radiation encountered to the hostile environment in space is considered. Results are reviewed from recent studies aimed at the identification of these radiations, determinations of their flux, energy spectra, and particle composition, and laboratory studies of the biological effects of these radiations within space simulators. A scheme is presented that divides the region surrounding the Earth into 5 areas representing different doses and dose rates of radiation to which astronauts may be exposed per mission profile. It is pointed out that radiation dose management and dose accounting on each astronaut will become more necessary as space operations are expanded. A radiation dose planning chart is presented that is based on astronaut age and it is suggested that training schedules for astronauts should consider the radiation dose that may be encountered during planned missions. Results of a series of studies on Rhesus monkeys exposed to a combination of ^{60}Co γ radiation and Po-Be neutrons at dose rates of 0.25, 0.50, 1.0, and 4 rad/hr at intervals of 4, 7, and 12 days with each exposure lasting for 16 hr showed that even though some animals accumulated radiation doses of 600 rad the animals survived and demonstrated no discernible detrimental performance decrement over a 3 to 10 year post-radiation observation time. It is suggested that a fixed maximum permissible radiation dose for astronauts will not be feasible since flexibility is necessary for each specific mission and also for each astronaut population. (C.H.)

32963 (AD–627686, pp 455-64) CYTOGENETIC EFFECTS OF PROTON IRRADIATION. Prince, John E. (Aerospace Medical Div., Brooks AFB, Tex.).

Cytokinetic studies of monolayers of epithelial (amnion) cells exposed to 10 Mev protons at dosage levels of 1,200 to 43,117 rad were carried out using shutterless camera-microscope with culture chamber and phase contrast optics. Results showed that permanent mitotic arrest was caused by high doses while lower doses induced hypertrophy of the cytoplasm and nucleus within 2 days. The effects of proton irradiation were irreversible, indicative of profound metabolic and structural alterations of the cells. Implications of the findings in studies of the biological effects of space flight conditions are briefly discussed. (18 references.) (C.H.)

32964 (ORO-648) SEMIANNUAL PROGRESS REPORT, JULY 1-DECEMBER 31, 1965. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). May 1966. Contract AT(40-1)-Gen-242. 174p. Dep. mn. CFSTI $5.00 cy, $1.00 mn.

Progress is reported on work in veterinary medicine, reproductive physiology, radiation pathology, physiological effects of radiations, large animal nutrition, dairy nutrition, poultry nutrition, fission product chemistry of soils, and radiobotany. Separate abstracts were prepared for each of the nine sections. (H.G.D.)

For abstracts of individual sections see: 32907-32909, 32965-32969, and 33260.

32965 (ORO-648, pp 1-25) VETERINARY MEDICINE. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Progress is reported on studies directed toward the clinical aspects of radiation injury associated with early and late effects. Investigations of early effects deal primarily with survival and basic problems of acute irradiation injury of animals, such as: the effects of irradiation on blood pressure responses to epinephrine and acetylcholine in rats; blood-gut interfaces of cattle; maternal-fetal placental inferface of cattle; and unilateral vs. bilateral irradiation of swine. The principal objective of the late effects studies was to ascertain by clinical investigations, indications of delayed damage to animals surviving irradiation. Late effects of gamma, neutron, or mixed gamma-neutron irradiation on cattle burros, sheep, or swine showed that: mortality in burros surviving neutron-gamma irradiation from an atomic detonation at 8.5 yrs post-exposure was similar in each dose group, whereas mortality in burros surviving gamma irradiation for periods of 11.5 and 14.5 yrs appeared to be dose-dependent; the mortality rate in swine exposed to neutron-gamma radiation was highest of all the animals surviving external radiation exposures; death of irradiated burros was related to blood dyscrasias, loss in body weight, and various forms of enteritis. Enteritis and neoplasia of the uterus, small intestine, and liver were the principal lesions observed in swine. Mortality in cattle and sheep was generally associated with infection. Data are tabulated. (H.G.D.)

32966 (ORO-648, pp 26-35) PHYSIOLOGY OF REPRODUCTION. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Investigations in reproductive physiology were directed towards a better understanding of the effects of radiation on the reproductive cycle in large animals from spermatogenesis and ovogenesis through the first few months post parturition. Rats and rabbits were used to determine whether techniques used in large animals are applicable in small animals. Progress is reported on studies of the effects of irradiation on lifetime fertility in cows; postnatal development of the bovine ovary; effects of prenatal irradiation on morphological development in lambs; and the underlying differences between human and swine leukocytes that would account for the failure of radioinduced chromosomal aberrations to persist in swine cells as is the case in man. (H.G.D.)

32967 (ORO-648, pp 36-55) RADIATION PATHOLOGY. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Studies in radiation pathology were directed primarily toward the analyses of death patterns of irradiated animals through the close examination of necropsies. During the report period, 107 cadavers from four families were subjected to macroscopic examinations by pathologists, including 10 cattle, 4 burros, 2 Shetland ponies, 31 sheep, and 60 swine. Findings of the necropsies of these animals are tabulated. An additional study was concerned with the acute radiotoxicity of ^{144}Ce after intravenous injection of the substance in sheep. Investigations were initiated on all stillborn and available newborn pigs for the purpose of determining the incidence of neoplasia. (H.G.D.)

32968 (ORO-648, pp 56-61) PHYSIOLOGICAL EFFECTS OF RADIATION. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Physiological events occurring as a result of whole-body irradiation in animals were examined. The studies were oriented toward the accumulation of data on formation of complexes in irradiated animals; their isolation and biological significance. Progress is reported on: biological indicators in animals; exsanguinotransfusion in sheep whose blood was interchanged by that of lethally irradiated donors; and radiation tumorigenesis in rats. (H.G.D.)

32969 (ORO-648, pp 123-58) RADIOBOTANY. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Genetic effects of ionizing radiation on plant tissues (embryos, buds, and pollen) and environmental factors affecting such effects were investigated. Research is reported on: effects of gamma radiation and fast neutrons on Vigna sinensis seeds; influence of environment and end-point on the assessment of seed radiosensitivity; fast neutron and gamma radiation studies with chrysanthemums; induction of chimeric bracts in Euphorbia pulcherrima (Poinsettia); embryonic features and dormant seed sensitivity to fast neutrons; hybrid zygote and pro-embryo irradiation in cotton; quantitative changes induced by seed irradiation; and interaction of moisture and gamma rays on fern spores. (H.G.D.)

32970 HAZARDS OF CANCER FROM ULTRAVIOLET LIGHT. Blum, Harold F. (National Cancer Inst., Bethesda, Md. Princeton Univ., N. J.). Amer. Ind. Hyg. Ass. J., 27: 299-302(May-June 1966).

Direct quantitative comparison cannot be drawn between experimental induction of cancer in laboratory animals with ultraviolet light and the hazard of skin cancer in man resulting from this agent. Reasons for this are: the very different optics in the two cases, ultraviolet light penetrating to deeper tissues in mice than in man and hence producing different types of cancer; quantitatively indeterminable biologic differences between man and experimental animals; and the fact that reliable statistics permitting comparison of incidence of skin cancer with incidence of exposure to ultraviolet B of sunlight are sparse and difficult to obtain. The cumulative carcinogenic effect of repeated doses, clearly shown in animal experiments, makes it important to consider this hazard in terms of repeated exposure, whether to sunlight or to artificial sources of ultraviolet light or to a combination of both, rather than in terms of the magnitude of single doses. (auth)

32971 EFFECT OF ANATOMIC LOCATION AND TIME ON ULTRAVIOLET ERYTHEMA. Olson, Robert L.; Sayre, Robert M.; Everett, Mark Allen (Univ. of Oklahoma, Oklahoma City). Arch. Dermatol., 93: 211-15(Feb. 1966).

The relation of time of observation to the erythema response was investigated in 13 healthy young adults not recently exposed to sunlight. One-cm squares of abdominal skin were exposed to graduated amounts of uv light from a xenon arc monochromator at nine wavelengths between 250 and 310 mμ. Erythema observations were recorded at 4, 6, 8, 12, and 24 hr. The erythema response to skin to uv light was characterized as to quantity of energy, wavelength, time of observation, and anatomic site of testing. Both the min erythema dose (MED) and the color of the erythema response vary with wavelength. Short wavelength erythema is pink, while longer wavelength erythema is darker and

redder. Although erythema varies with both time and wavelength, the optimum time for observation is eight hr. The time of day at which the uv light is administered does not affect the eight-hr MED value. The MED not only varies markedly with site but also the relative response to the different wavelengths varies with anatomic location. The trunk is best suited for erythema studies because of greater sensitivity and a more uniform response to uv light at all wavelengths. The abdomen, ventral, forearm, and leg have markedly different MED values. The abdomen is uniformly sensitive, but the range of response on the forearm and leg is great. It is suggested that previous comparisons of erythema responses under different experimental conditions, including different observation times and different anatomic sites, have led to erroneous conclusions regarding the relative effectiveness of various wavelengths of uv light. (BBB)

32972 INVESTIGATION IN RADIATION CHIMERAS OF THE QUESTION OF THE ORIGIN OF TISSUE EOSINOPHILS IN THE MOUSE. Schaefer, H. E.; Fischer, R. (Univ., Bonn). Arch. Pathol., Anat. Physiol., 340: 243-50(1966). (In German).

Histochemical examination of eosinophils of different species, on the basis of enzyme content of these cells in uterine tissue, allows discrimination between mouse and rat eosinophils. The rat eosinophils, in contrast to those of the mouse, show marked alkaline phosphatase activity. Experiments were devised on the basis of this phenomenon to ascertain the orgin of the eosinophils in the uterus of the mouse. As a result of heterologous transplantation of rat bone marrow into lethally (925 R) x-irradiated female mice, chimeras were produced whose myelopoietic system represented that of the donor rat. The eosinophilic leucocytes in estrogen-stimulated mouse uterus and the corresponding cells appearing in the blood and bone marrow were identical in their morphological and enzyme histochemical qualities to the eosinophils of the donor type. That is, they showed strong alkaline phosphatase activity, normally absent in the mouse eosinophils. If estrogen-injected, x-irradiated mice received no rat bone marrow or if their grafts were rejected, no infiltration of the uterus stroma by alkaline phosphatase-positive eosinophils of the rat type could be observed. These results provide further proof for the hematogenous origin of the so-called tissue eosinophils. (BBB)

32973 PATHOLOGY OF RADIATION CATARACTS. Kanbai, G. G. Azerbaidzh. Med. Zh., No. 1, 33-8(1965). (In Russian).

Rabbits were given local x-ray doses of 450, 600, 800, and 1000 R to the eye with the rest of the body being shielded from radiation. With a 450 R dose one out of 6 rabbits developed a cataract one year after the irradiation. With a 650 R dose one out of 4 rabbits developed yellowish spots in the back part of the lens 9 months after the irradiation. With an 800 R dose one out of 4 rabbits showed degenerative lens changes 11 months after the irradiation. With a 1000 R dose 3 out of 6 rabbits showed cataracts at 4, 5, and 11 months after the irradiation. All the rabbits were subjected to opthalmic and microscopic examinations before and after the irradiation. Histologic studies were carried out on ordinary transverse lens sections. A detailed account of the pathological and dystrophic changes is given. (TTT)

32974 EFFECTS OF γ RADIATION ON PHYSIO-BIOCHEMICAL MODIFICATIONS IN TUBERS AND PLANTS. Grechushnikov, A. I.; Serebrenikov, V. S.; Kiryukhin, V. P. Biokhim. Plod. Ovoshch., Akad. Nauk SSSR, Inst. Biokhim., 2: 191-201(July 1964). (In Russian).

The irradiation of plant tubers with γ doses of 300 and 1000 R increases the sugar concentration of the tubers as a result of the increased destruction of starch. The increase of the destruction of starch in tubers for 300 R dose and the increased utilization of the sugars in the aging process accelerates the germination of buds of tuber eyes. Doses of 1000 R disrupt the aging process which affects the reduction of the number of intergrown eye buds and the accumulation of sugar. Plants grown from tubers irradiated with 300 R are characterized by increased concentration of chlorophyl in leaves and the leaves intensively assimilate carbon dioxide. After irradiation of the mother tuber with 1000 R, the photosynthetic process in plants grown from it was depressed and the leaves contained less chlorophyl. Products formed in the photosynthetic process in leaves, grown from tubers irradiated with 300 R, are rapidly distributed to other parts of the plant, among them the tuber. As a result of this, the sugar concentration in the leaves is rapidly depressed. The increase of the concentration of dissolved hydrocarbon in the leaves occurs at doses of 1000 R as a result of the retardation of the distribution of photosynthetic products. (tr-auth)

32975 INFLUENCE OF PUPAL AGE ON SENSITIVITY TO RADIATION. Ducoff, H. S.; Bosma, Gayle C. (Univ. of Illinois, Urbana). Biol. Bull., 130: 151-6(Apr. 1966).

Tribolium confusum exposed to germicidal uv at any time during the 5-day pupal period exhibits a high incidence of gross morphological deformities, particularly of the wings, in the emerging adult, although the greatest sensitivity to this effect occurs on the first day of pupation. Mortality within two weeks is by far the greatest, however, if uv irradiation is performed on the third day of pupation. By contrast, sensitivity to both lethality and abnormality-induction after x ray exposure is greatest on the first day of pupation and declines progressively thereafter, with the sharpest decline occurring late on the second day. These differences are partially explained by the fact that energy absorbed from x rays is distributed rather uniformly throughout the pupa, whereas most of the uv energy is absorbed in the outermost tissue layers. (auth)

32976 COMPARISON OF THE EFFECTS OF RADIATION AND DEOXYRIBONUCLEIC ACIDS ON THE MITOSIS IN ROOTS OF VICIA FABA. Slotova, J.; Karpfel, Z. (Biophysical Inst., Brno). Biol. Plant., Acad. Sci. Bohemoslov., 8: 10-19(1966).

The effect of isologous, homologous, or heterologous DNA on the chromosomes of cells of Vicia faba root meristem was compared with the effect of ionizing radiation. Tips of the primary roots were exposed to a single 150-R dose of x rays six days after germination of the seeds. When the time course of aberrations was examined in irradiated beams the max percentage of aberrations was observed immediately after irradiation. With the application of nonisologous DNA, max aberrations occurred after 8–16 hr. At all the time-intervals studied, an increased number of aberrations was found during metaphase, as compared with anaphase, both after irradiation and after application of DNA. A comparison of isologous, homologous, and heterologous DNA as inductors of chromosomal aberrations supported previous findings and showed that the efficiency of DNA depends on the genetic difference between donor and recipient cells. It was observed that after irradiation the distribution of aberrations between individual chromosomes is proportional to their total length, whereas the effect of heterologous DNA is mainly reflected in the damage to small chromosomes. After irradiation chromatid aberrations are formed at relatively short time intervals and only later do chromosomal aberrations appear. On the other hand, heterologous DNA brings about a predominance of chromatid aberrations at all time intervals. (TCO)

32977 ELECTRON MICROSCOPE STUDIES OF THE MORPHOLOGICAL AND FUNCTIONAL CHARACTERISTICS OF THROMBOCYTES DURING AN ACUTE RADIATION SICKNESS. Batikyan, I. G. (Div. of Radiobiology, Academy of Medical Sciences, USSR). Biol. Zh. Arm., 19: No. 2, 79-84(Feb. 1966). (In Russian).

A single whole-body irradiation dose of 800 R in the rabbit induced a marked functional incapacity of the thrombocytes which indicated disturbances in the submicroscopic structure of the blood platelets (lysis, pycnosis, and vacuolation). The 800-R dose also caused character-

istic changes in the electron-microscopic thrombocytograms (decrease of young and mature cells, and increase of old, degenerative, and vacuole-containing forms). The process of thrombocyte generation took place in the first hours after irradiation which indicated a high radiosensitivity of the blood platelets. On the 7th, 10th, and 13th day after irradiation, destruction of the thrombocytes, pycnoses, and vacuolations reached a maximum. During acute radiation sickness, the appearance of giant thrombocytes was characteristic within 5 to 17 days after irradiation. Regeneration of the thrombocytes began 15 to 17 days after irradiation. On the 25th to 30th day the blood platelets were noticeably normalized. (tr-auth)

32978 GROWTH, DEVELOPMENT, AND YIELD OF SEEDS EXPOSED TO X IRRADIATION AT VARIOUS EMBRYONIC AGES. Babayan, V. O.; Avakyan, D. O.; Babayan, R. S.; Azatyan, R. A. (Lab. of Radiation Genetics, Academy of Sciences, Armenian SSR). Biol. Zh. Arm., 19: No. 2, 96-101(Feb. 1966). (In Russian).

The radiosensitivity of immature wheat seeds was significantly higher than that of mature seeds. It increased with a decrease in age of the seed. The radiosensitivity of 28-day old seeds was equal to, and in some cases lower than, that of mature seeds. The high radiosensitivity of immature seeds is explained by the comparatively high water concentration during germination, high mitotic activity of the differentiating embryos, and the fact that the casings of the sections of the cell microstructure are not completely formed. The effects of x irradiation depend, to a great extent, on the conditions of plant cultivation. (tr-auth)

32979 ENERGY EXPENDED BY ALPHA PARTICLES IN LUNG TISSUE. Haque, A. K. M. M. (Borough Polytechnic, London). Brit. J. Appl. Phys., 17: 905-16(July 1966).

A method is described, based on relative $-dE/dx$ values in air, for calculating the energy expenditure of nonrelativistic α particles in a condensed medium; this has then been applied to the case of the respiratory system on which α-emitting daughter products of radon are deposited. The present procedure takes into account the detailed variation of $-dE/dx$ along the path of an α particle, and the energy dissipated by the α particles emitted both from the "near wall" and the "far wall" have been calculated at several points inside the vulnerable tissue. The total energy ("near wall" and "far wall" contributions together) dissipated in the tissue, as calculated by Altshuler, Nelson and Kuschner on the assumption that the α particle spends twice $(-dE/dx)_{av}$ at the surface of the tissue, which falls linearly to zero at the end of the range, almost always represented an over-estimation: the deviations from the present calculations are smaller for the narrower tubes. Jacobi's results, obtained by employing Snyder and Neufeld's $-dE/dx$ values, do not lend themselves to meaningful comparison as he obtains the total energy spent at one point only by multiplying the "near wall" contribution by an arbitrary factor 2. (auth)

32980 OLD-TUBERCULIN-INDUCED RADIORESISTANCE ON HUMAN LYMPHOCYTES IN VITRO. Stefani, S. (Loyola Univ., Chicago). Brit. J. Haematol., 12: 345-50(May 1966).

The in vitro effect was investigated of old tuberculin (OT) and x rays on suspensions of lymphocytes from patients with positive or negative skin tests to purified protein derivative (PPD). Old tuberculin showed a radioprotective effect on lymphocytes from PPD-positive patients without active tuberculosis, 2400 R having about the same cytotoxic effect on the OT-treated lymphocytes as 300 R on the untreated cells. No radioprotective effect was observed in the old-tuberculin-treated suspension of lymphocytes from PPD-negative patients. Blood lymphocytes from seven patients with active tuberculosis showed a variable response to irradiation in the presence of old tuberculin. A relation between old-tuberculin concentration, blastoid transformation, and radioprotection was observed. It is postulated that the radioprotective effect of old tuberculin was on an immunological basis. (auth)

32981 PIGMENT MOSAICS IN IRRADIATED HUMAN SKIN: A NEW TEST OF CELLULAR SURVIVAL CURVE THEORY. Cohen, Lionel (General Hospital, Johannesburg). Brit. J. Radiol., 39: 533-6(July 1966).

The appearance, at the site of healed desquamative skin reactions in pigmented subjects, of visible, irregularly pigmented domains, presumably consisting of clones derived from individual surviving cells, suggests a possible approach to testing cell survival curve models for normal tissues irradiated in vivo. The mean cellular lethal dose, the extrapolation number, and the mean generation time for cells proliferating in the intervals between fractions may be estimated from the size and density of the pigmented domains observed in patients receiving various conventionally fractionated radiotherapy routines. (auth)

32982 EFFECTS OF CYCLOTRON NEUTRONS ON THE INTACT MOUSE THYMUS UNDER NORMAL AND HYPOXIC CONDITIONS. Wright, E. A. (St. Mary's Hospital, London); Bewley, D. K.; Parnell, C. J. Brit. J. Radiol., 39: 551-3(July 1966).

Mice were irradiated with fast neutrons (mean energy 6 Mev) under normal and hypoxic conditions. Hypoxia was induced by brief periods of nitrogen breathing. Observations of the thymus weight two days later gave an oxygen enhancement ratio of 1.7 ± 0.2. Earlier irradiations with 8 Mev electrons gave an OER of 2.7 ± 0.3. This gives a gain factor of 1.6 ± 0.2. The RBE relative to 8 Mev electrons is 2.35 in air and 3.82 in nitrogen. (auth)

32983 EPIDEMIOLOGIC STUDY OF MALIGNANCIES OF THE OVARIES. West, Raymond O. (Takoma Clinic, Inc., Silver Spring, Md.). Cancer, 19: 1001-7(July 1966).

The descriptive epidemiology of ovarian malignancies, including age, marital status, and race, is discussed. A study of 97 cases of ovarian malignancies compared to 97 cases of benign ovarian tumors was analyzed. Between most of the variables there were no statistically significant differences. Three variables, however, were of special importance: history of x irradiation; history of internalization of hormones; and history of mumps parotitis. In the first 2 variables no statiscally significant differences were found. The conclusion was that exposure to x irradiation and the internalization of hormones did not influence the onset of ovarian malignancies. With the third variable a p value of 0.007 was encountered. The difference favored having mumps. The benign controls gave a history of mumps parotitis far more often than did the patients with ovarian malignancies. A causal association with a possible protective value is suggested. (auth)

32984 TISSUE CULTURE OF CHICK SPLEEN FOLLOWING GAMMA IRRADIATION IN OVO AND IN VITRO. Ortega, Nohemi (Pasadena Foundation for Medical Research, Calif.). Com. Nac. Energ. Nucl. (Mex.) [Pub.], No. 212, 21-48(Feb. 1966).

Cobalt-60 gamma irradiation of chick embryonic spleen explanted in vitro resulted in accelerated death of cells and marked alteration of the ratio of one type to another. Cell motility was reduced with increasing doses of radiation. A transitory appearance of large macrophages was also observed. No significant difference was found between irradiation in ovo and in vitro. (auth)

32985 ACTION OF IONIZING RADIATION ON THE HeLa CELL. I. PHOTON MICROSCOPE STUDY. Driessens, J.; Cappelaere, P.; Glaux, G.; Herbin, Y. (Institut de Recherches sur le Cancer, Lille). Compt. Rend. Soc. Biol., 159: 1279-82(1965). (In French).

A morphological study was made of the nucleus and cytoplasm of HeLa cells exposed to radiation doses of 22,000, 15,000, 7,000, and 2,200, 700, and 400 R. Examinations were made 1 hr, 48 hrs, 4 days, and 8 days after irradiation. The morphological modifications shown by the HeLa cell were a completely classical mitotic inhibition that was immediate and maximum 90 min after irradiation regardless of the dose used. If the doses were small there was the possibility of the reappearance of cellular divisions,

abnormal for the most part, 48 hrs later. There were considerable alterations in the form and the dimension in the interkinetic cell nuclei. The nucleus became more and more giant, multilobed, and with a vegetating or multinucleated aspect. A progressive impairment of the nucleolas was observed on the fourth day principally at high doses. The cytoplasmic lesions were much less noticeable even for massive radiation doses. (J.S.R.)

32986 THE RELATION BETWEEN CERTAIN PHYSICAL AND CHEMICAL CHANGES IN IRRADIATED SKIN AND ITS ABILITY OF RAPID TRANSFORMATION INTO CORNEA. Popov, V. V.; Melikhova, O. P.; Kozlov, Yu. P. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 165: 241-4(Nov. 1, 1965). (In Russian).

X-irradiated (1500 R) and normal tadpoles (Rana temporaria) were placed in aqueous solutions of monomeric acrylamide labeled with ^{14}C, a continuous beta emitter, for varying lengths of time, and after removal were fixed sectioned, and examined autoradiographically. Changes were indicated by polymerization and copolymerization in the animal. After 30 min in the solution the free radical content in the irradiated epidermis was 3 times that in the normal. After 2 days the amount of labeled copolymer in the experimental organisms was half that of the controls. The ratio was the same after 12 days but at the later time the free radical content had increased, indicating a higher metabolic rate. The beta tracks in the organs and tissues were followed. In the unirradiated animals the amount of free radicals was directly proportional to the level of metabolism, particularly in the anterior epithelium of the crystalline lens and gray matter. In the irradiated animals the free radical reaction showed a surge after 1 day with a drop at 2 days and then an increase; but it did not become normal even after 12 days. (TTT)

32987 PROLONGATION OF THE CELL CYCLE IN TRADESCANTIA ROOT TIPS BY CONTINUOUS GAMMA IRRADIATION. Wimber, D. E. (Univ. of Oregon, Eugene). Exp. Cell Res., 42: 296-301(May 1966).

An alteration occurs in the duration of the cell cycle in Tradescantia roots after a prolonged exposure to γ radiation of 29 rads per day. No change in the cell cycle is found when it is measured between 1 to 2 days of irradiation. However, after 9 days of continuous irradiation, a marked increase in the duration of the cell cycle is noted. Some increase occurs in the duration of DNA synthesis, but the major portion of the change is in the G_2 and G_1 periods. The total cycle may be prolonged from 3 to 4 times its control value. (auth)

32988 EFFECTS OF SEED TREATMENT WITH FAST NEUTRONS ON SOME MORPHOLOGICAL CHARACTERS OF M_1 SEEDLINGS IN VICIA SATIVA L. AND VICIA VILLOSA ROTH. Zannone, L.; Mariani, G. (Istituto Nazionale di Genetica, Rome). Genet. Agr., 19: 263-70 (1965). (In Italian).

The effects of fast-neutron irradiation at doses up to 6000 rep on seed germination and seedling development in Vicia sativa L. and the effects of doses of 800 and 1200 rep on the leaf size of Vicia sativa L. and Vicia villosa Roth are reported. The existence of a high correlation coefficient among different morphological seedling elements was confirmed. The percentage germination in the control was 97 to 99% up to 2400 rep and fell to 60% at 3200 rep and 18% at 4000 rep. (tr-auth)

32989 INDUCTION OF INVERTANT MALES IN E. COLI K12. Espardellier-Joset, F.; Fournier, R. (Institut du Radium, Paris). Contracts AT(30-1)-2803; 005-61-1 B 10 F. Genet. Res., 7: 353-61(June 1966).

A number of Hfr strains were studied as to the action of radiations on the transmission of their genetic material to female cells. They form two classes, one in which irradiation produces only lesions that prevent transfer, and one which new modes of chromosome transfer seem to be induced. One group of strains, derived from a common F^+ male, appears to give rise to the same induced mode of transfer, while no correlation could be found in the other Hfr's studied. (auth)

32990 PRODUCTION OF HEREDITARY CHANGES IN THE POTATO BY EXPOSURE TO GAMMA RAYS. Yashina, J. M.; Kirsanova, E. V. Genetika, No. 1, 53-8 (Jan. 1966). (In Russian).

Generative mutations in the potato were studied. Dry seeds of four hybrid combinations obtained from crosses of early maturing parents were ^{60}Co gamma irradiated in doses of 10, 20, 30, and 45 kR. Seedlings of both the irradiated and control variants were investigated in the course of three years. Appearance of changes overstepping the species limits was judged to be a criterion of the mutational variability in the heterozygous population of seedlings. Two types of induced changes were found: mutation of the leaf plate (coalescence of the leaf lobes) and mutation of the inflorescence (fasciation and vestigial flowers). The types of changes found manifest parallelism of variation both in the course of spontaneous and induced mutagenesis. A large number of productive and early forms was selected among variants of the irradiated series. (auth)

32991 THE USE OF MUTAGENIC FACTORS FOR THE SELECTION OF GIBBERELLIN-PRODUCING STRAINS OF FUSARIUM MONILIFORME SHELD. Erokhina, L. I.; Sokolova, E. V. (Kurchatov Inst. of Atomic Energy, Moscow). Genetika, No. 1, 109-15(Jan. 1966). (In Russian).

Fast neutrons and γ rays were found to be more effective in inducing variability in the gibberellin-producing character of F. moniliforme as compared with uv light. The number of plus variants was higher when the doses of fast neutrons and γ rays with more lethal effect (survival ranged from 0.12 to 0.00002%) were used. Three active mutants were obtained as a result of fast neutron and γ irradiation, uv light, and ethylenimine combined action and step selection as well. These mutants differed from the original strain both in productivity and in morphological traits. (auth)

32992 STUDY OF COMBINED EFFECTS OF CHEMICAL MUTAGENS AND ULTRAVIOLET RAYS UPON THE EMERGENCE OF BACK MUTATIONS IN ESCHERICHIA COLI. Panfilova, Z. I.; Voronina, E. N.; Poslovina, A. S.; Gorjuhova, N. M.; Salganik, R. I. (Inst. of Cytology and Genetics, Academy of Sciences, Novosibirsk, USSR). Genetika, No. 2, 49-56(Feb. 1966). (In Russian).

The combined effects of chemical mutagens (hydroxylamine and formaldehyde) and uv rays on the emergence of back mutations in auxotrophic strains of E. coli was investigated. It was established that combination of formaldehyde with gradually increasing doses of uv rays (80, 160, 315 erg/mm^2) increased the number of back mutations in E. coli B_{12} and leu^+, thr^+ mutations in E. coli K-12 WP^+ thr, leu, B_1 lac, gal, met, mtol, str^r. The effects of simultaneous application of the factors mentioned surpassed that of each of the factors taken separately. Combination of hydroxylamine with the same doses of uv rays caused a decrease in back mutations number in E. coli 113-3/B_{12}, but increased the number of leu and thr back mutations in E. coli K-12. Combination of uv rays with formaldehyde or hydroxylamine decreased the number of penicillin-resistant mutants induced by uv rays in E. coli K-12W. The differences in sensitivity of various loci (leu and thr) to simultaneous effects of small doses of uv rays and formaldehyde were established. It is suggested that breakage of hydrogen connections in definite DNA regions increases the possibility of nitrogen bases located in these regions to react with chemical mutagens which may change the number and the mutation spectrum. (P.C.H.)

32993 COMBINED EFFECTS ON X RAYS AND STREPTOMYCIN ON THE MUTABILITY OF CHLORELLA. Tugarinov, V. V.; Kuznetzov, V. V. (Univ. of Leningrad). Genetika, No. 2, 57-63(Feb. 1966). (In Russian).

The frequency of pigment mutations in Chlorella induced by x rays and streptomycin was studied. Three strains were used: strain B sensitive to streptomycin (SS); the strain resistant to 500 units/ml of streptomycin (Sr-500), and the strain resistant to 3000 units/ml of streptomycin (Sr-3000). Treatment of SS and Sr-500 strains with strepto-

mycin (20 units/ml — this dose is not mutagenic) after irradiation increased considerably the frequency of mutations comparing with the frequency of mutations induced with x rays. Highly resistant strain Sr-3000 showed the same level of mutability under combined treatment with x rays and streptomycin and under isolated action of x rays. All three strains showed no difference regarding frequency of mutations induced by x rays. (auth)

32994 COMPARATIVE STUDY OF RADIOSENSITIVITY OF DIFFERENT DROSOPHILA STRAINS. Tikhomirova, M. M. (Univ. of Leningrad). Genetika, No. 3, 93-7(Mar. 1966). (In Russian).

The frequency of breakage of X-chromosomes, estimated by appearance of exceptional males (of the X0 type) was used as an indicator of radiosensitivity of a Drosophila line. Irradiation was effected by means of x rays of the same regime at a dose of 3000 R. Comparative analysis of three lines showed that one of them is relatively radiosensitive while the other two lines are radioresistant. Consecutive action of x rays and high temperature caused increase of frequency of appearance of exceptional males whereas radiosensitivity of the lines became leveled. Leveling of radiosensitivity was due to a varying manifestation of the aftereffect in different lines. Discussion is presented on whether the mechanism of determining radiosensitivity of Drosophila lines depends on correlation of real and potential changes taking place at the moment of irradiation and realization grade of the latter. (auth)

32995 ON FREQUENCY OF X-RAY-INDUCED CHROMOSOME BREAKS AT VARIOUS STAGES OF DROSOPHILA MELANOGASTER SPERMATOGENESIS. Vatti, K. V. (Univ. of Leningrad). Genetika, No. 3, 98-104(Mar. 1966). (In Russian).

Breaks of the ring X-chromosome of Drosophila induced by various x-ray doses (100-3000 R) at different stages of spermatogenesis were studied. It was found by means of the brood pattern method that frequency of breaks is characterized by a linear dependence on the irradiation dose at meiotic and postmeiotic stages of spermatogenesis. In contrast to this the spermatogonia do not follow such a dependence pattern within the same dosage range and are characterized by a number of breaks, approaching that of the control. A connection between breaks frequency and male fertility was observed due to irradiation of different stages at spermatogenesis. Thus increase of breaks number due to irradiation of spermatids with massive doses resulted in stressed fertility decrease; decrease of breaks number in irradiated spermatogonia caused stressed fertility increase, which is tentatively explained by an irrepairable elimination of the damaged spermatids and a simultaneous substitution of damaged spermatogonia for intact cells. A dependence of breaks frequency induced in the spermatogonia on the stage of ontogenesis being irradiated was also found. (auth)

32996 YIELD OF VIRULENT MUTANTS IN IRRADIATED POPULATIONS OF TEMPERATE PHAGE λ AS AN INDEX OF DISTURBANCE OF THE FUNCTION OF REGULATION (REPRESSION) OF GENETICAL INFORMATION. Fradkin, G. E. (Inst. of Biological Physics, Moscow). Genetika, No. 3, 106-14(Mar. 1966). (In Russian).

Direct and indirect effects of γ radiation on the yield of Vi-mutants in temperate phage populations were studied. It was found that indirect effect of γ rays in contrast to the direct effect causes along with an increase of radiation doses an increment of Vi-mutants yield. Increase of Vi-mutants yield is considered as an index of partial DNA damage of temperate λ phage testifying disturbance of the function of the control (repression) of genetical information. (auth)

32997 CYTOGENETIC RADIOSENSITIVITY OF MAMMAL MARROW CELLS IN DIFFERENTIAL PHASES OF THE CELL CYCLE IN VIVO. Alexandrov, I. D. (Inst. of Biological Physics, Moscow). Genetika, No. 5, 59-67(May 1966). (In Russian).

An investigation was made of the character and grade of radiation damage of chromosomes of unripe bone marrow cells of the mouse in the course of the first mitotic cycle after x irradiation at a dose of 50 R. Qualitative reaction to irradiation of chromosomes of erythropoetic cells in the course of mitotic cycle in vivo was similar to that described in the literature for chromosomes of plant and animal cells of other types. The maximum of chromosome rearrangements corresponded to the period of division of cells irradiated in the prophase. Among cells irradiated in the interphase the ones that had been irradiated during the period of DNA synthesis displayed most chromosome rearrangement. Data were obtained suggesting chromosome reparation of erythropoetic cells before the first postradiational divisions. (auth)

32998 COMPARATIVE STUDY OF MUTAGENIC ACTION OF INCORPORATED ISOTOPES OF THE PRINCIPAL ORGANOGENIC ELEMENTS. I. MUTAGENIC EFFECT OF INCORPORATED ^{14}C (REVERSION TOWARDS PROTOTROPHY OF A DIPLOID YEAST HOMOZYGOUS FOR ADENINE DEPENDENCE). Pluchennik, H. (Univ. of Leningrad). Genetika, No. 5, 117-24(May 1966). (In Russian).

A comparative study of the mutagenic effect of incorporated carbon-14 was carried out: in one case where the isotope was introduced into nucleic acids; and in the second case — preferably into protein structures. It was found that at the same rate of splitting in the DNA, carbon-14 localized in DNA caused an incomparably lesser genetic effect than carbon-14 localized preferably in protein structures. Also the ratio of genetic effects stated cannot be considered as proof of an insignificant role of $^{14}C \xrightarrow{\beta^-} {}^{14}N$ transmutation in DNA under biological action of incorporated carbon-14 as the adenine → 8-aza-adenine conversion evidently is not accompanied by a mutagenic effect. (auth)

32999 COMPARATIVE STUDY OF MUTAGENIC ACTION OF INCORPORATED ISOTOPES OF THE PRINCIPAL ORGANOGENIC ELEMENTS. II. MUTAGENIC EFFECT OF INCORPORATED ^{32}P (REVERSION TOWARDS PROTOTROPHY OF A DIPLOID YEAST HOMOZYGOUS FOR ADENINE DEPENDENCE). Pluchennik, H. (Univ. of Leningrad). Genetika, No. 5, 125-8(May 1966). (In Russian).

The kinetics of reversion towards prototrophy of an adenine dependent diploid yeast induced by incorporated phosphorus-32 were studied. Comparison of mutagenic effectivity of phosphorus-32 and carbon-14 showed that phosphorus-32 induced mutations mainly via the transmutational mechanism. Comparison of mutagenic effectivity of the $^{32}P \xrightarrow{\beta^-} {}^{32}S$ transmutation and the $^{14}C \xrightarrow{\beta^-} {}^{14}N$ transmutation showed a considerably higher effectivity of the latter with respect to induction of viable mutations. Low mutagenic effectivity of the transmutation $^{32}P \xrightarrow{\beta^-} {}^{32}S$ was considered as an experimental confirmation of the correctness of modern conceptions as to the role of DNA in the molecular organization of chromosomes in unicellular objects. (auth)

33000 COMPARATIVE STUDY OF MUTAGENIC ACTION OF INCORPORATED ISOTOPES OF THE PRINCIPAL ORGANOGENIC ELEMENTS. III. MUTAGENIC EFFECT OF INCORPORATED ^{35}S (REVERSION TOWARDS PROTOTROPHY OF A DIPLOID YEAST HOMOZYGOUS FOR ADENINE DEPENDENCE). Pluchennik, H. (Univ. of Leningrad). Genetika, No. 5, 129-34(May 1966). (In Russian).

A comparative study of mutagenic effectivity of incorporated isotopes of the principal organogenic elements carbon-14, phosphorus-32, and sulfur-35 was carried out on an adenine dependent diploid yeast toward prototrophy. It was found that the genetic effect corresponding to a similar dose of intracellular radiation of the isotopes mentioned was highest in the case of sulfur-35 and lowest in the case of carbon-14. In order to explain these results a hypothesis was founded admitting the existence in the cell of a feedback system between DNA and protein structures. A method of effective treatment of protein structures (transmutation $^{35}S \xrightarrow{\beta^-} {}^{35}Cl$) showing a way to experimentally study the role of proteins in heredity is proposed. (auth)

33001 ANALYSIS OF THE DOSE SURVIVAL DEPENDENCE OF YEAST CELLS TREATED WITH IONIZING

RADIATION. Barsukov, V. S.; Malinovskii, O. V.; Mityushova, N. M. (Pavlov Inst. of Physiology, Leningrad). Genetika, No. 5, 141-5(May 1966). (In Russian).

The dependence of a mean number of dominant lethals appearing in cells treated with γ radiation was analyzed. It was found that in the case of comparatively low radiation doses a practically quadratic dependence exists. This confirmed the presumption that double target chromosome rearrangements are the main cause of cell death. Variability of the parameters of viability curves (extrapolation value and mean lethal dose) which could serve as an argument against this presumption, may be explained on the ground of the conception of a reduced number of cell loci where rearrangements might take place. (auth)

33002 KINETICS OF CHROMOSOME DAMAGE REALIZATION IN YEAST CELLS PLATED ON NUTRIENT MEDIA AFTER GAMMA IRRADIATION. Barsukov, V. S.; Malinovskii, O. V.; Mityushova, N. M. (Pavlov Inst. of Physiology, Leningrad). Genetika, No. 5, 146-51(May 1966). (In Russian).

Dose survival dependence in gamma irradiated yeast cells kept on a nutritive medium was studied. The ability of the cells to recuperate on non-nutritive medium was also used as a test of reversibility of irradiation damage. Analysis of the data obtained showed that when the yeast cells begin to bud a period of rapid union of chromosome breaks takes place, whereupon the cells lose the property of recuperation on a non-nutritive medium. Chromosome restitution and formation of chromosome rearrangements presents two sides of one and the same process and represents realization of chromosome damage. (auth)

33003 STUDIES ON THE INTESTINAL ABSORPTION OF ^{59}Fe IN THE IRRADIATED RAT. Cultrera, G.; Santagati, G.; Robustelli Della Cuna, G.; Zanolla, W. (Univ., Pavia, Italy). Haematologica, 49: 1057-70(1964). (In Italian).

The absorption of iron, traced with ^{59}Fe, from the gastrointestinal tract was studied in 5 groups of male, Richter strain rats: Group A, nonirradiated controls; Group B, whole-body irradiated with a 300-R dose of x rays; Group B_1, 300-R with shielding of hind limbs; Group C, whole-body irradiated with 600 R; and Group C_1, 600 R with hind limb shielding. Two days after irradiation the rats received 1 μC of ^{59}Fe by gastric intubation, and were sacrificed 6 hr to 7 days later. Distribution of ^{59}Fe in various tissues was examined. In the respective five groups (A, B, B_1, C, C_1) the absorbed dose was 43, 35, 33, 12, and 29% of the administered dose, while the estimated percentage of the absorbed dose utilized for erythropoiesis was 60, 20, 30, 25, and 40. At a one-week interval the percentage of the dose in various tissues was: bone marrow, 6.4, 7, 3.9, 1.8, 1.1; spleen, 2.5, 0.2, 0.8, 0.3, 0.2, and carcass, 2.6, 14.3, 15.6, 2.3, 1.7. These results suggest two causes for reduced absorption of iron after irradiation: (1) injury to the intestinal mucosa, with decreased function of the Fe-absorbing cells; and (2) injury to hematopoietic tissue, with lowered demand for iron for erythropoiesis. (BBB)

33004 AGE OF ONSET OF DIABETES MELLITUS IN RELATION TO ATOMIC BOMB EXPOSURE. Wada, Sunao; Yamashita, Yoshihiko (Hiroshima Univ.). Hiroshima J. Med. Sci., 13: 265-75(Dec. 1964).

The age of onset of diabetes mellitus in 180 diabetics exposed within 2,000 meters from the hypocenter to the atomic bomb in Hiroshima was observed to see if there was any influence of the exposure. Nonexposed diabetics at the authors' clinic, in university hospitals throughout Japan, and at Joslin clinic in the U. S. were employed as controls. The age distribution curve for nonexposed Japanese diabetics was very similar to that for American diabetics. Both curves showed a peak at the 6th decade with an almost symmetrical decline on each side of the peak. The age of onset of disease in the exposed diabetics was also very similar to that in the nonexposed diabetics. There was no tendency for the peak to shift to the left, and no unusual cusp was seen on the left slope of the curve. This did not support the speculation that the exposure might accelerate the development of diabetes mellitus. (auth)

33005 LEUKEMOGENIC ACTIVITY OF CENTRIFUGATES FROM IRRADIATED MOUSE THYMUS AND BONE MARROW. Haran-Ghera, Nechama (Weizmann Inst. of Science, Rehovoth, Israel). Int. J. Cancer, 1: 81-7(Jan. 1966).

Tests were made for the presence of a leukemogenic agent in mice in which radiation leukemogenesis was potentiated by urethane. C57BL mice were exposed to four weekly doses of 170 R whole-body x irradiation and, 3 days after each exposure, injected intraperitoneally with urethane (1 mg/g body weight). Leukemogenic activity of centrifugates from radiation-induced lymphomas and irradiated tissues of C57BL mice was tested by injecting these directly into 5- to 7-day-old thymus implants beneath the kidney capsule in thymectomized, irradiated (550 R) hosts of the same strain. Of 12 centrifugates from radiation-induced lymphomas six were active, inducing about 14% lymphomas at an average latent period of 166 days. Centrifugates from thymus plus bone marrow taken from donor mice 5 or 10 days after irradiation demonstrated up to 30% leukemic activity. Centrifugates of irradiated tissues taken 20, 30, 45, and 60 days after irradiation showed only dubious activity. Thymic tissue, taken from the same irradiated donor mice, transplanted beneath the kidney capsule of normal hosts, revealed neoplastic transformation only when taken from donors 30 days after completion of the irradiation. Mice treated concurrently with x rays and urethane yielded 75% lymphoma incidence, with a marked decrease in the average latent period. The first passage of this active centrifugate revealed an 80% lymphoma incidence, with a short latent period. Centrifugates of tissues taken 20, 30, and 45 days after irradiation and urethane treatment showed no activity. It is concluded that irradiation causes the release of a transmissible leukemogenic agent in C57BL mice, and that urethane potentiates the activity of this agent. (TCO)

33006 TUMOR-SPECIFIC IMMUNITY AGAINST SPONTANEOUS RAT TUMORS. Baldwin, R. W. (Univ. of Nottingham, Eng.). Int. J. Cancer, 1: 257-64(May 15, 1966).

The antigenicities of two spontaneously developing rat tumors, a reticulum cell sarcoma and a squamous cell carcinoma, were studied. With the reticulum cell sarcoma, no immunity could be demonstrated following either destruction of tumor grafts or implantation of heavily irradiated (14,500 R) tumor into isogeneic hosts. Destruction of subcutaneous grafts by ligation of their blood supply proved to be effective for inducing immunity to the squamous cell carcinoma. In contrast, implantation of heavily irradiated tumor was completely ineffective in producing resistance. The level of immunity induced following destruction of subcutaneous grafts of the squamous cell carcinoma varied markedly and this was ascribed to the tendency of the tumor to metastasize. Moreover, in some instances, rats immune to subcutaneous challenges with this tumor eventually developed lung metastases. While the present studies demonstrate the antigenicity of a spontaneously arising tumor, the level of resistance which can be produced is much lower than that detected with carcinogen-induced tumors. Furthermore, immunological control of tumor metastases appears to be a problem not previously encountered with carcinogen-induced tumors and this may reflect differences in the antigenicities of the two tumor types. (auth)

33007 DELAYED ULTRASTRUCTURAL CHANGES IN DUODENAL CRYPTS OF X-IRRADIATED MICE. Hugon, J.; Maisin, J. R.; Borgers, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Int. J. Radiat. Biol., 10: 113-22(Feb. 28, 1966).

Ultrastructural lesions of the duodenal crypt of whole-body irradiated mice are studied in the days following irradiation with 1350 R of x rays. The high cylindrical epithelium of stem cells is reduced to a flat cuboidal

epithelium with atrophied microvilli; all the subcellular organites are affected: few ribosomes, irregular mitochondria, pale nuclei with very condensed nucleoli. The Paneth cells are abnormal with disappearance of normal zymogen granules. Only Kultchisky cells are almost intact. These findings are discussed and compared with alterations provoked by certain chemical toxics. (auth)

33008 RADIATION-SENSITIVITY DIFFERENCES WITHIN CELL-DIVISION CYCLES DURING MOUSE CLEAVAGE. Russell, Liane Brauch; Montgomery, Clyde Saylors (Oak Ridge National Lab., Tenn.). Int. J. Radiat. Biol., 10: 151-64(Feb. 28, 1966). (ORNL-P-1473).

Acute x rays (100 and 200 R) were administered to pregnant females at one of three times on day 0 (day of the copulation plug) or one of two times on day 1. The effects studied were embryonic mortality and sex-chromosome loss in survivors. On day 0, sensitivity is very high shortly after sperm entry (completion of second meiotic division) and again in early pronuclear stage, then becomes low in later pronuclear stage (probably post DNA synthesis). On day 1, sensitivity is relatively low in resting 2-cell stage, then becomes very high at the beginning of the second cleavage. Results suggest that death occurs at about the time of implantation and that chance determines whether or not an implantation reaction will occur. From the high proportion of embryos showing sub-nuclei after irradiation, it was concluded that the most, if not all, of the death is the result of aneuploidy. The mechanism for aneuploidy production may vary depending on nuclear state at the time of irradiation. This probably accounts for differences in frequencies of induced death. Parallelism with dominant-lethal type of death is striking. The present results are not in conflict with earlier indications that autosomes and sex chromosomes have similar sensitivities to radiation-induced loss in zygote states. (auth)

33009 ENGORGEMENT AND REPRODUCTION OF LONE STAR TICKS (AMBLYOMMA AMERICANUM (L.)) TREATED WITH GAMMA RADIATION. Drummond, R. O.; Medley, J. G.; Graham, O. H. (Dept. of Agriculture, Agricultural Research Service, Kerrville, Tex.). Int. J. Radiat. Biol., 10: 183-8(Feb. 28, 1966).

Most unengorged nymphal lone-star ticks (Amblyomma americanum (L.)) exposed to 250 to 7500 R of gamma radiation from a ^{60}Co source engorged normally, and those irradiated with 1000 R or less moulted to adults; those irradiated with 2500 R or greater did not. Nymphs irradiated after completion of engorgement became increasingly tolerant to radiation during the moulting period. Those irradiated with 2500 R one day after engorgement did not moult, whereas those irradiated with 15000 R two weeks after engorgement moulted. Egg-laying and egg hatch were used as criteria to determine the effects of radiation on the reproduction of adults from irradiated nymphs or irradiated adults. Irradiation with 250 R had little or no effect on reproduction. With females, reproduction was reduced at a dose of 500 r and prevented at a dose of 1000 R. With males, reproduction was slightly reduced at a dose of 500 R, and at a dose of 1000 R, effects on reproduction varied according to the point in development at which the males were irradiated. With both sexes, irradiation with 2500 R or more prevented reproduction. (auth)

33010 PATHOMORPHOLOGICAL CHANGES IN HEMATOPOIETIC ORGANS OF MICE EXPOSED TO THE SYNERGISTIC EFFECTS OF IONIZING RADIATION AND DYNAMIC SPACE FLIGHT FACTORS. Gaidamakin, N. A.; Petrukhin, V. G.; Antipov, V. V.; Saksonov, P. P.; Shashkov, V. S. Izv. Akad. Nauk SSSR, Ser. Biol., No. 3, 346-54 (May-June 1966). (In Russian).

A study was carried out to reveal pathomorphological changes in hemopoietic organs of mice exposed to the synergistic effect of proton radiaton and vibration and to that of γ irradiation and acceleration. A single total exposure of animals to vibration three days and, particularly, a day prior to proton radiation, increased the lesion of the spleen lymphoid tissue and decreased that of hemopoietic cells of myelo- and erythroblastic processes in the spleen and marrow. The recovery of all types of hemopoiesis in these organs increased. The effect of vibration applied three and especially five days after proton radiation enhanced destructive changes in hemopoietic organs. Necrotic foci were found in these organs during the recovery period, and reparative processes were shown to slow down. The effect of acceleration applied a day before γ-irradiation decreased the depletion of the hemopoietic organs and promoted their recovery. The action of acceleration applied a day after γ irradiation produced no effect upon the level at which the organs were damaged by the penetrating radiation. (auth)

33011 CELLULAR KINETICS OF PHAGOCYTIC CELLS IN IMMUNIZED X-IRRADIATED MICE. Muramatsu, Shigeru; Morita, Toshiteru; Sohmura, Yasunobu (Kyoto Univ.). J. Immunol., 95: 1134-41(Dec. 1965).

A large number of phagocytic cells were found in clusters in the water-in-oil emulsion which had been injected subcutaneously into mice, and the advantages in dealing with these cells, rather than with peritoneal exudates, are that all of these cells gather only in response to a given stimulus and can be harvested without much loss. Mice were injected with 1 ml of complete Freund adjuvant emulsion containing BCG, and were irradiated at 500 R 24 hr later. Irradiation prevented the proliferation of the cells which participated in the immune response, which depends on the immunologically competent cells which are the precursors of antibody-producing cells, and the phagocytic cells which ingest antigens and may give the antigenic information to the immunologically competent cells. Irradiation at 500 R did not interfere with the patterns of cellular response expressed in terms of the proportion of each cell type. This indicates that the radiosensitivity of the various types of phagocytic cells is not different. The results show that radiation does not affect the motility of phagocytic cells. The decrease of the cell numbers by x radiation is ascribed to the inadequate supply of cells caused by the depression of the cell proliferation. Autoradiographic analyses support this interpretation. Although the decrease of the deleterious effect of radiation on antibody response with time after antigenic stimulation has been previously ascribed solely to the increase in the number of immunologically competent cells, the findings indicate that phagocytic cells attacking antigens also increase with time after immunization. The amount of antigen included in a unit number of cells can be augmented by radiation. The mechanism involved in the enhancement of phagocytosis caused by irradiation is discussed. The amount of antigen ingested by the whole population of cells is much smaller at any time in irradiated mice than in unirradiated mice because of the fewer cells, even when the amount of antigen in a unit cell number is much larger in irradiated mice. The reduction of the total amount of antigen ingested by phagocytic cells in irradiated animals may cause the lack of antigenic information for immunologically competent cells. It is concluded that the radiosensitivity of the antibody response is related to the reduction of the total amount of antigen ingested by phagocytic cells. (BBB)

33012 DEVELOPMENT AND RADIO-RESPONSE OF THE PRENATAL BOVINE OVARY. Erickson, B. H. (Univ. of Tennessee, Oak Ridge). J. Reprod. Fertil., 10: 97-105(Feb. 1966).

This study was undertaken to determine the effects of ionizing radiation on the bovine germ cell at varying stages in its prenatal life cycle, and to determine through quantitative and qualitative observations of the nonirradiated fetal ovary whether changes in the radiosensitivity of germ cells could be correlated with stages of morphogenesis. Seventy gravid cows were exposed to a whole-body dose of 400 R of ^{60}Co γ radiation rate of 0.7 R/min. Observations were made on 49 bovine fetuses taken at varying stages of gestation. Total germ-cell numbers increased from a low of 16,000 at Day 50 to a high of 2,700,000 at

Day 110. From Day 110 numbers declined abruptly to 107,000 at Day 170 and the ovaries of four fetuses at 270 days of gestation (average length of gestation, 283 days) contained an average of 68,000 germ cells. Prenatally irradiated heifers were slaughtered at 9 or 23 months of age. Microscopic examinations of their ovaries revealed that irradiation was apparently without effect during the interval of 17 to 59 days of gestation, and of questionable effect from 59 to 119 days of gestation. Irradiation administered during the 119- to 154-day interval, however, diminished germ-cell numbers by ~68%. From Day 154 to term, irradiation was again without effect. The mitotically active oogonium was probably the cell affected during the interval of 59 to 119 days of gestation and the drastic germinal decline during the 119- to 154-day interval was believed to be related to the progression of oocytes from zygotene to pachytene, a transition during which the oocyte under normal conditions is highly susceptible to death. (TCO)

33013 DOSAGE-DEPENDENT INFLUENCE OF GAMMA-IRRADIATION (^{60}Co) ON THE CHANGES OCCURRING IN THE INCREASE OF WATER CONTENT AND DRY MATTER IN WHEAT VARIETIES. Pozsar, Bela I. Kiserl. Kozlem., A. Novenytermesz., 61: 73-85(1963). (In Hungarian).

Embryonic wheat tissues with the largest water content were oxidized to the highest degree by gamma irradiation, while the entirely dehydrated organs commence to be dehydrogenated only after very high irradiation doses. Compared with the control the uptake of radioactive phosphate isotope was stimulated by 5 kR gamma (Co-60) dosage in all four wheat varieties examined (Bánkúti 1201, Fleischmann 239, Skorospelka, Produttore). Under the effect of 10 kR doses the 32-PO_4 uptake was still further increased. The dry matter augmentation under effect of medium doses was the most favorable in the Produttore variety and the case of Bánkúti 1201. On the basis of hydration-increases caused by gamma irradiation the four varieties may be classified into three groups, namely varieties with growing hydration, hydration remaining unvariable, and dehydration. A dry matter augmentation was caused by irradiation with different gamma doses only in the varieties in which the degree of hydration was raised by the respective dose. Dehydration was never accompanied by matter augmentation. From the point of view of a correlation between the dry matter augmentation and increase of hydration the Fleischmann 239 variety was entirely devoid. (P.C.H.)

33014 MECHANISM EDUCING VOMITING AT THE TIME OF PRIMARY REACTION TO IRRADIATION. Varshamov, Yu. L. (Kirov Military Medical Order of Lenin Academy, Leningrad). Med. Radiol., 11: No. 1, 12-14 (Jan. 1966). (In Russian).

The extent to which central and reflex mechanisms participate in the development of vomiting subsequent to irradiation was investigated in x irradiated dogs. The central type vomiting was produced with morphine and that of the reflex type with copper sulfate and by stimulating with electric current the cervical portion of the vagus taken out to a skin loop. Experimentation demonstrated the efficacy of chlorpromazine in arresting the morphine-induced vomiting and of the one occurring after irradiation. In a weakly marked primary reaction to irradiation the administration of subliminal morphine doses resulted in vomiting. Under similar conditions subliminal stimulation of the vagus failed to elicit vomiting. The results suggest that the vomiting after irradiation develops according to the central type at the expense of the chemoreceptive trigger zone stimulation. (auth)

33015 THE EFFECT PRODUCED UPON THE IMMUNE TRANSFORMATION OF HEMATOPOIESIS FOLLOWING TRANSPLANTATION OF THE BONE MARROW TO DOGS IN ACUTE RADIATION INJURY. Chertkov, I. L.; Maksimenko, A. S.; Novikova, M. N.; Raushenbakh, M. O. (Inst. of Hematology and Blood Transfusion, Moscow). Med. Radiol., 11: No. 1, 42-7(Jan. 1966). (In Russian).

Attempts to prevent transformation of hemopoietic cells into lymphocytes following transplantation of allogenic bone marrow to dogs x irradiated at a dose of 1000 R are reported. Introduction of a bacterial pyrogen following bone marrow transplantation caused accelerated maturation of hemopoietic cells and because of this no graft proliferation was observed. Incubation of the bone marrow at 37° for 2 hours did not affect the capacity of hemopoietic cells to become transformed into lymphoid ones. Such a transformation occurred also with a preliminary treatment of the recipients with 6-mercaptopurine in a total dose of 50 mg/kg, prior to irradiation. Preliminary immunization of the donor with tissues taken from future recipients did not speed up the transformation of hemopoiesis. The significance of the data for the understanding of the mechanisms governing differentiation of hemopoietic cells is discussed. (auth)

33016 PATHOGENESIS OF EXPERIMENTAL LEUKEMIA INDUCED BY X RAYS. Svyatukhin, M. V.; Sorokina, Yu. D.; Turgunov, M. B. (Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol., 11: No. 1, 47-53(Jan. 1966). (In Russian).

Whole-body x irradiation caused myeloid leukemia in mongrel albino mice and lymphatic leukemia with tumor-like enlargement of the thymus in mice of the C_{57}-black strain. These two forms of leukemia react differently to chemical antiradiation protection. Administration of 5-metoxytryptamine prior to irradiation reduced the incidence of lymphatic leukemia and exerted no essential effect on the development of myeloid leukemia. There are, apparently, essential differences in the mechanism of development of these two forms of leukemia. Indirect mechanisms are of greatest importance for the development of lymphatic leukemia. The possibility of utilizing data concerning experimental radiation leukemia in respect to human cases is discussed. (auth)

33017 COURSE OF NECROSIS OF THE MYOCARDIUM AGAINST THE BACKGROUND OF EXPERIMENTAL RADIATION SICKNESS. Ariel, B. M. (Central Inst. of Research in Medical Radiology, Leningrad). Med. Radiol., 11: No. 1, 53-9(Jan. 1966). (In Russian).

The morphogenesis of experimental myocardial necrosis obtained by the method of orthostatic collapse in x irradiated rabbits is described. In such instances there was seen an extensive involvement of the myocardium, usually in the right cardiac ventricle. The pathological changes were of a two-phase character: at first there occurred necrosis associated with orthostatic collapse and then, at the peak of radiation sickness, there developed fresh foci of necrosis of the cardiac muscular fibers. The latter did not completely resolve and became calcified and incapsulated. (auth)

33018 PERIPHERAL BLOOD AND LYMPH CIRCULATION UNDER THE EFFECT OF LOW DOSES OF IONIZING RADIATION. Slesarev, V. V. (Turkmen Medical Inst., Ashkhabad, USSR). Med. Radiol., 11: No. 1, 59-66(Jan. 1966). (In Russian).

Experiments conducted on 33 dogs by using intravital vaso- and lymphography demonstrated the effect produced by low doses of x radiation (1.5, 2, 4, and 15 R) upon the peripheral blood and lymph circulation. A total of 750 vasographic and lymphographic explorations were made. (auth)

33019 DECELERATION OF POST-TRAUMATIC RESTORATION AS MANIFESTATION OF IRREVERSIBLE COMPONENT OF RADIATION INJURY. Akoev, I. G.; Mikhalkin, M. P. Med. Radiol., 11: No. 1, 66-70(Jan. 1966). (In Russian).

The authors report that deceleration of the restoration process after injuries of the bones and skin in animals following radiation sickness is associated with the irreversible component of radiation injury. The extent of this deceleration depends on the dose, conditions of irradiation, and type of tissue injured. (auth)

33020 THE EFFECT OF ^{32}P ON THE FECUNDITY OF AEDES AEGYPTI (L.) AND ITS USE IN DETERMINING

BLOOD MEAL VOLUMES. Bennett, Gordon F. (Ontario Research Foundation, Toronto). Mosquito News, 25: 465-9(Dec. 1965).

The volume of blood ingested by Aedes aegypti was determined by a gravimetric method and found to be 1.63 mm^3/mosquito. The volume of blood ingested, determined by a method involving the use of ^{32}P, was 3.0 mm^3. It was found that the fecundity of mosquitoes fed on ^{32}P-labeled blood was lower than that of mosquitoes fed on non-labeled blood. The lowered fecundity persisted when radioactive mosquitoes were fed on nonlabeled blood. The viability of radioactive eggs (at the level of radiation used) was not affected by the presence of the isotope. (Public Health Abstr.)

33021 HISTOPATHOLOGICAL STUDIES ON THE ADRENAL GLANDS OF THE ATOMIC BOMB SURVIVORS. Tsuchiyama, Hideo (Nagasaki Univ.). Nagasaki Igakkai Zasshi, 37: 91-102(May-June 1962). (In Japanese).

Histopathological and histochemical studies were conducted on the adrenal glands of 119 atomic bombing survivors and 75 controls. The pathological changes seen in the glands of atomic bombing survivors included atrophy and disarrangement of the cortical cell layers, hypertrophy of cells of the fascicular and reticular zones, inflammatory cell infiltration, fibrosis and necrosis of the cortex, with deep staining and pigmentation of the reticular zone. The histochemical changes included increased amounts of lipids in the hypertrophic cells of the fascicular and reticular zones. A decrease of lipids in the fascicular zones was also found, and cholesterol and ketosteroid levels of tissues were decreased. In autopsy cases showing disorders of circulating system, including myocardial fibrosis, there were increases or decreases in lipids of the fascicular zones. In cases of pulmonary tuberculosis, adrenal cellular atrophy and decrease of lipid granules were observed. The survivors who were within 2 km of the hypocenter showed the highest incidence of adrenal cortical disturbances. Incidence of cell atrophy of survivors gradually decreased 7-11 years after the exposure to atomic bombing. (BBB)

33022 INDUCTION OF LUNG TUMORS BY THE ACTION OF RADIATION AND URETHANE. Lindop, Patricia J.; Rotblat, J. (St. Bartholomew's Hospital Medical Coll., London). Nature, 210: 1392-3(June 25, 1966).

Investigations previously reported by Foley and Cole (Radiat. Res., 27: 87(1966)) on the incidence of lung tumors in mice exposed to different doses of x rays, followed by an injection of urethane are discussed. In these studies it was assumed that the lung tumors were induced by the urethane and that the x rays had an inhibitory effect on the tumor incidence. However, after studying the results, it seems that the results can also be interpreted in an entirely different way, that is, that the main action of urethane is not to induce tumors but to promote, or to speed up, the appearance of potential tumors induced by radiation or other causes. Calculations supporting this criterion are reported. (P.C.H.)

33023 EFFECTS OF FAST NEUTRONS ON EYE COLOR MUTATIONS IN DAHLBOMINUS. Baldwin, W. F.; Cross, W. G. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nature, 210: 1396-7(June 25, 1966).

The mutagenic effects of 14-Mev neutrons as compared to ^{60}Co gamma rays in adult females of Dahlbominus fuscipennis were studied. The numbers of four classes of eye color mutants (carmine, claret, chestnum, and russet) were scored following exposure of Dahlbominum adults. The total dose, whether of neutron or of gamma rays, was about 750 rads. The neutron exposures produced about 30% more mutations. However, as the age of the insects at the time of exposure was increased from 12 to 108 hr, the frequency of mutations rose about twofold for both neutrons and gamma rays. Overlapping of the standard limits for each age group demonstrated that no significant differences were detected between the results with gamma rays and with neutrons. (P.C.H.)

33024 CHANGES OF ACETYL COENZYME A CONTENT OF MOUSE LIVER AFTER IRRADIATION IN VIVO. Berndt, J.; Gaumert, R. (Univ., Freiburg i. B.). Naturwissenschaften, 53: 307(June 1966). (In German).

Modifications of the acetyl coenzyme A content in the liver of whole-body irradiated mice was followed for a long period after the exposure. The female mice were irradiated with doses of 690 R under conditions of normal feeding and starvation for 24 hrs. The acetyl coenzyme A content determined was followed for 11 days. In irradiated and fed mice there was no modification of the acetyl coenzyme A content except for the 2 hrs following irradiation. In the hungry mice there was first an increase followed by a decrease with a subsequent increase on the second day followed by a continuous decrease. The cause of this decrease was not clarified. (J.S.R.)

33025 PATHOLOGICAL STUDY OF THE TERRITORIAL CHANGES IN THE RAT BRAIN IRRADIATED BY X-RAYS. Nakamura, Kunitake (Nihon Univ., Japan). Nichidai Igaku Zasshi, 24: 813-21(Sept. 1965). (In Japanese).

The territorial difference of changes in the rat brain caused by the x-irradiation was examined pathologically. 42 Wistar rats were divided into 5 groups and x irradiated with doses varying from 300 to 12000 R. Majority was sacrificed 3 days after irradiation was completed. Examination revealed that there were two types of lesions encountered: one perivascular edema and the other cellular changes. In the range of 300 to 6000 R the nervous changes were mainly characterized by the perivascular edema which might reach its maximum resulting spongiosis like appearance and secondary ganglion cell degeneration coincident with that of occasional oligodendroglia. For the doses of 6000 to 12000 R the histological changes consisted principally of nuclear changes (Kernpyknose) of Purkinje and that of supraoptic nuclei. In view of the territorial analysis, the perivascular edema took place in rather diffuse pattern predisposing cerebellar and cerebral cortexes and hippocampus. On the contrary, midbrain, pons, and medulla were rather well preserved. As to the neuronal changes, the granular layer of the cerebellum including Purkinje cell was mostly and severely affected. Also schwere Veranderung of the ganglion cell of the cerebral cortex, hippocampus, and supraoptic nuclei was frequently encountered. Conclusively, cerebellar and cerebral cortexes and some nuclei of the basal ganglia were predisposed by either vascular or cellular changes. (auth)

33026 STUDY ON THE EFFECTS OF RADIATION PRODUCED BY MEANS OF AN ATOMIC REACTOR UPON ASCARIS EGGS. Yabuki, Ikuya (Nihon Univ., Japan). Nichidai Igaku Zasshi, 24: 1007-17(Dec. 1965). (In Japanese).

Eggs of Pig Ascaris (Ascaris suum) were irradiated with radiation (neutron and γ rays) produced by an atomic reactor. Development of the irradiated Ascaris eggs was evidently always inhibited. The longer irradiation times (i.e., irradiation dosage) produced larger inhibitory effects. (auth)

33027 DOSE-DEPENDENCE OF RADIATION INDUCED, EMBRYONIC DAMAGES. Shibata, Kyoko (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Koshu Eisei Zasshi, 12: 681-9(Aug. 1965). (In Japanese).

The dose-dependence of embryonic damages after whole-body x-irradiation (50–400 R) in utero on the 5th and 8th gestation days was macroscopically investigated in terms of frequencies of malformations, resorptions, and intrauterine deaths in mice. The macroscopic investigation demonstrated that 50% of the fetuses irradiated to 300 R at the 5th gestation day was more or less misshapen including resorptions during the embryonic development. On the other hand, the fetuses that were irradiated at the 8th day of pregnancy were damaged even at a dosage of 150 R to the same degree as above mentioned, i.e., the embryonic damages were dependent on the developmental stage of embryo at the time of irradiation as well as on the radiation dosage. Radiation effects at the 5th gestation day were found to be half as much as the effect of irradiation at the 8th gestation day, when the embryos were observed at the 18th gestation day. The ability to recover from radioin-

duced damages during embryonic development is discussed as based on histological observations in connection with both the applied doses and the stage-dependence of the radioinduced embryonic damages. (auth)

33028 RELATION BETWEEN THE LOSS OF ACID-FASTNESS DUE TO THE UV IRRADIATION AND THE VIRULENCE OF TUBERCLE BACILLI. Murohashi, Toyoho; Yoshida, Konosuke (National Inst. of Health, Japan). Nippon Saikingaku Zasshi, 20: 233-8(May 1965). (In Japanese).

Tubercle bacilli were deprived completely of their acid-fast stainability by uv irradiation for a given time period. Obviously a longer time period of uv irradiation is required for the complete loss of acid-fastness in the virulent type strains than in the a- or low-virulent ones. This seems to suggest a difference in the cell wall structure between these two types of tubercle bacilli and the virulence of tubercle bacilli may be primarily attributable to the proper cell wall structure. Based on the results obtained, a very simple method was devised to distinguish, even roughly, these two types of strain by the staining of smears. The relation between the virulence and the cell wall structure of tubercle bacilli is discussed. (auth)

33029 SPUR TYPES OF APPLE AND CHERRY PRODUCED BY IONIZING RADIATION. Lapins, K. O. (Pomology Section, Research Station, Summerland, British Columbia). Proc. Wash. State Hort. Ass., 59: 93-5(1963).

This report describes a program on irradiation of fruit-tree material, aiming to produce mutants with reduced tree size. The work was initiated with apple varieties in which natural spur types were not available. Dormant scions of McIntosh, Spartan, Golden Delicious, Yellow Transparent, Tydeman's Early, and Newtown apple, and Lambert and Van cherry were irradiated with γ rays from radiocobalt. The percentage of mutant trees with reduced growth was relatively high. Various degrees of dwarfing were introduced in all varieties where a sufficiently large number of irradiated grafts were under observation. Average values of growth characteristics for 30 compact McIntosh selections, observed over a three-year period, are given. The selected McIntosh compacts produced about two-thirds of the terminal growth of regular McIntosh. The buds and fruit spurs in the compacts were about 35% closer than in standards. Individual leaves were slightly smaller, but the total leaf area per unit of shoot length was slightly larger in the compacts. Growth characteristics of Spartan and Golden Delicious mutants were similar to those described in McIntosh. Considerable variation in fruit size and shape was observed. Many mutants, especially in the McIntosh variety and of the extreme dwarfs, produced unsatisfactory fruit (flat, irregular, ribbed, and grooved). Several selections of compact growth, or spur types, were made from irradiated Lambert cherry trees. However, many compact selections were completely or highly sterile, and some showed severely distorted foliage or chlorophyll deficiencies. Two selections were maintained which are compact in growth, with close spurs; they blossom profusely, set heavily, and the fruit is characteristic of the Lambert variety. (TCO)

33030 REDUCTION OF RADIATION RESISTANCE IN FRUIT SPOILAGE FUNGI BY CHEMICALS. Georgopoulos, S. G.; Macris, B.; Georgiadou, E. (Nuclear Research Center Democritos, Athens). Pytopathology, 56: 230-4(Feb. 1966).

Radiosensitization tests were conducted on Penicillium italicum, Rhizopus nigricans, Botrytis cinerea, and Aureobasidium pullulans. The first three fungi are among the most important fungi in postharvest spoilage of fruits; the fourth is a highly radiation-resistant pseudosaccharomycete, capable of damaging fruits after irradiation. Aspergillus niger and Candida tropicalis were also examined. Cobalt-60 γ irradiation was applied at a dose rate of 20 krad/hr to doses of 5 to 100 krad. No effective radiosensitization of these six species by chemicals was possible under conditions of anoxia. In the presence of oxygen, iodoacetamide was an effective radiosensitizer for all fungi tested. Iodoacetic acid also sensitized the two species on which it was tested. 1-Naphthol achieved a considerable increase of radiolethality in A. pullulans and C. tropicalis but not in the four species of typically filamentous fungi. The radiation doses used were often high enough to kill a considerable number of spores even in N_2. Fifty krad in N_2 resulted in 62% reduction of colony formation by P. italicum. This lethality was not increased by 50 ppM iodoacetamide. Sensitization of A. pullulans by the same compound in air was high even with a dose of 5 krad, whereas in N_2 the lethality due to a six times higher dose was not considerably increased. These results indicate a requirement for the presence of oxygen. (TCO)

33031 ULTRAVIOLET LIGHT INACTIVATION AND RECOVERY OF BACTERIAL RECOMBINATION AND NUCLEIC ACID SYNTHESIS. Doudney, C. O.; Bruce, Betty J. (Univ. of Texas M. D. Anderson Hospital and Tumor Inst., Houston). Contract AT(40-1)-2139. Radiat. Res., 28: 597-608(July 1966).

While uv irradiation of E. coli strain Hfr G6 his prior to mating results in an exponential relation between dose and inactivation of recombination throughout the dose range studied, inactivation of cellular survival is described by a sigmoidal type of curve, the second phase of which is correlated with the nonrepairable inactivation of RNA and DNA synthesis by uv. Thus, the damage responsible for inactivation of capacity to recombine can be separated in terms of effective dose from the damage responsible for nonrepairable inactivation of DNA synthesis and the lethal effect on the cell. A postirradiation recovery of capacity to recombine is demonstrated, which occurs in correlation with DNA synthesis following lower doses of uv where capacity to form DNA is completely recoverable. Postirradiation recovery of capacity to recombine can be prevented by blockage of DNA synthesis by various metabolic inhibitors or conditions and by withholding thymine in a thymine-requiring derivative of strain G6 his. The nonrecoverable damage to DNA synthesis by uv at higher doses also blocks recovery of capacity for recombination. (auth)

33032 A SELECTED STRAIN OF AEDES AEGYPTI RESISTANT TO GAMMA RADIATION. Terzian, Levon A.; Stahler, Nathan (Naval Medical Research Inst., Bethesda, Md.). Radiat. Res., 28: 643-6(July 1966).

Eggs (10 days old) of both a selected strain and the parent NMRI strain of the mosquito Aedes aegypti were exposed to 2000 R gamma radiation at the rate of approximately 200 R/min in air. The eggs of the selected strain were found to be more resistant to the effects of this dose of gamma radiation than were the eggs of the parent strain, since a significantly higher proportion of the larvae from irradiated eggs survived to become viable adults. On the other hand, adults of the selected strain derived from eggs not exposed to radiation died more quickly and had a significantly shorter life span than the adults from the non-irradiated eggs of the parent colony. (P.C.H.)

33033 ENHANCEMENT OF RADIATION-INDUCED MITOTIC INHIBITION BY BUdR INCORPORATION IN L CELLS. Schneider, D. O.; Johns, R. M. (McMaster Univ., Hamilton, Ont.). Radiat. Res., 28: 657-67(July 1966).

Incorporation of 5-bromodeoxyuridine (BUdR) into L-strain mouse cells was found to markedly enhance mitotic inhibition induced by cobalt-60 γ irradiation. The prolongation of the mitotic delay was found to increase with cell growth time in the presence of BUdR, with the most rapid change in radiosensitivity occurring during the first 100 hours of growth in the drug. Since it was found that BUdR is an analog of thymidine and is incorporated into cellular DNA, the results indicate that DNA must in some way be involved in the response. The manner in which the dose-response curves are changed suggests that the degree of radiosensitization may vary around the cell division cycle. (auth)

33034 IONIZING RADIATION AND BACTERIA: NATURE OF THE EFFECT OF IRRADIATED MEDIUM.

Frey, H. E.; Pollard, Ernest C. (Pennsylvania State Univ., University Park). Radiat. Res., 28: 668-76(July 1966).

The effects of gamma irradiated medium on E. coli cells was studied. First of all it was found that irradiated medium causes a cessation of DNA synthesis in E. coli 15T⁻L⁻. However, the effect is removed by catalase. Irradiated medium also causes a halt in cell growth whose duration depends on the degree of irradiation. This halt is removed by catalase. The same effect can be obtained with reagent hydrogen peroxide necessary to produce a given delay in cell growth agrees with the amount measured in irradiated medium by the starch-potassium iodide technique. Live cells remove hydrogen peroxide from the medium more rapidly than broken open cells. Autoclaved cells are without effect. The data suggest that bacterial cells can concentrate hydrogen peroxide. (auth)

33035 CELL POPULATION KINETICS IN THE INTESTINE OF CONTINUOUSLY IRRADIATED MICE, USING DOUBLE-LABELING AUTORADIOGRAPHY. Wimber, Donald E.; Lamerton, L. F. (Royal Cancer Hospital, Sutton, Eng.). Radiat. Res., 28: 694-700(July 1966).

A ^{14}C-, ^{3}H-thymidine double-labeling method was utilized to study the cell population changes in the epithelium of the ileum in mice continuously irradiated for 5 days at 50, 84, or 176 rads/day. The duration of DNA synthesis in control animals was found to be 6.4 ± 0.4 hours, and of mitosis, 0.4 hour. No major changes occurred in the duration of DNA synthesis or of mitosis at the dose rates tested. The number of cells per crypt was similar in the control and irradiated animals. A large amount of cell death and loss occurred at the dose levels examined. An enhanced cell production was indicated; this was probably effected by an increase in the number of proliferating cells per crypt or by a shortening of the cell cycle or by both. (auth)

33036 EFFECTS OF NEONATAL IRRADIATION ON POSTNATAL ACTIVITY AND ELIMINATION. Manosevitz, Martin; Rostkowski, John R. (Rutgers Univ., New Brunswick, N. J.). Radiat. Res., 28: 701-7(July 1966).

The effects of neonatal whole-body irradiation (300 R) on activity and elimination of SWR/J mice were studied. The results indicate that animals irradiated on day of birth weigh less at 45 days of age, eliminate more in the open field, and are more active. Significant sex and treatment interaction indicated that female subjects are more than twice as active in the open field as nonirradiated animals. These results are opposite those reported by others using rats. (auth)

33037 CLINICAL AND EXPERIMENTAL EXAMINATIONS OF THE EFFECT OF LOW X-RAY DOSES TO THE CENTRAL NERVOUS SYSTEM. Vasculescu, T.; D'Andre, H.; Ratiu, H.; Valeanu, V.; Andronescu, N.; Kovacs, M.; Nicoara, Z.; Papilian, V. V.; Rosenberg, A.; Diacu, L. (Medizinische Radiologie des Medizinisch-Pharmazeutischen Instituts, Cluj). Radiobiol.-Radiotherap., 7: 331-49 (1966). (In German).

The therapeutic use of the pathogenetic method of treatment with x-ray low doses (6–8–10 × 5–10 R in intervals from 5 to 7 days) is discussed. The diencephalohypophyseal region was irradiated in asthmatical syndrome, neuroses and secondary neurotic symptoms, parodontosis, oligophrenia, diencephalosis, and dyshormonosis. The method was theoretically established and clinically checked by comparing clinical observations with the results of tests that more or less express the functional condition of certain nervous centers and systems of reaction of organism as well as experiments on neurosis in dogs. For the purpose of optimal adaptation of the method to the different pathogenetic syndromes accessible to this treatment and in order to fit in each syndrome the technique of application as perfectly as possible to the individual conditions of a case, the role of technical (dose, dose rate, and rhythm of irradiation) and biological (individual reactivity) factors in causing therapeutical and eventual injurious effects was determined. For that purpose histopathological and histochemical examinations of rats, guinea-pigs, chickens, and dogs were used. Type, extent, and dynamics of certain alterations that occur after irradiation were determined in their dependence on the technical factors of irradiation and on the phylogenetic stage of development of experimental animals. (auth)

33038 MOUNTING OF A ^{60}Co IRRADIATION UNIT FOR BIOLOGICAL EXAMINATIONS. Nauber, G. (Deutsche Akademie der Wissenschaften, Berlin). Radiobiol.-Radiotherap., 7: 365-71(1966). (In German).

A source that had become useless for radiotherapy was used in a recently developed irradiation unit for biological examinations. The design of this unit and its electromotive transport mechanism are described. On October 10, 1964, the free-air dose rate was 60.6 R/min at a distance of 30 cm from the source. The field distribution of the dose in a plane normal to the central ray is plotted for two different distances. The device permits an irradiation of cell-suspensions or the like at a distance of only a few millimeters from the source. Finally, the results of protection measurements are reported. (auth)

33039 ULTRASTRUCTURAL STUDY OF THE DEVELOPMENT OF RADIATION INJURY IN THE LUNG. Phillips, Theodore L. Radiology, 87: 49-54(July 1966).

Radiation doses of 2,000 rads were given to the left hemithorax of rats. After intervals of from one hour to one year after irradiation, the lungs were studied with the electron microscope. The initial site of radiation damage appears to lie chiefly in the endothelium. This is sloughed, and the original endothelial space is replaced by collagen and mast-cell infiltrate. Some capillaries are recanalized by new endothelial cells. Eventually they attain an appearance similar to that of the original capillary but with a somewhat thickened endothelium and basement membrane. The mast cell contributes greatly to repair of the radiation damage and is closely associated with collagen and new capillary formation. It is stressed that the degree of damage after a given dose varies widely and that these observations were made on only small samples of lungs. (P.C.H.)

33040 RADIOSENSITIVITY OF THE TAMARIN TO WHOLE-BODY IRRADIATION. Porter, Raymond P.; Vuksanovic, Mario; Dauer, Maxwell (Univ. of Miami School of Medicine, Fla.). Radiology, 87: 74(July 1966).

Studies were made to determine the dose-lethality of the tamarin to gamma irradiation and to sequentially evaluate the changes in the peripheral blood cells resulting from various levels of whole-body irradiation. The acute lethality response of Tamarinum nigricollis yielded the $LD_{50/30}$ of 200 ± 57 rads at 95% confidence limits. The results also suggested that among the peripheral blood cells, those most vulnerable to irradiation are the platelets and/or their precursors in the bone marrow, the megakaryocytes. (P.C.H.)

33041 EARLY X-RADIATION EFFECTS ON SUBMICROSCOPIC STRUCTURES OF THE HEPATIC CELLS OF MICE. Kung, Yi-hung; Lee, Kun; Sze, Ching-yi; Ma, Ji-cheng; Chien, Chang-nien (Inst. of Experimental Medicine, Peking). Sci. Sinica (Peking), 15: 669-82(May 1966).

The ultrastructural changes of liver cells were observed from 5 min to 4 hr after x irradiation of 100 R and 500 R in dosage given locally on the liver of a white mouse. The earliest change appeared half an hour after irradiation with 100 R and 10 min after irradiation with 500 R. The first change was the dilatation of the endoplasmic reticulum, then it was followed by the focal diminution of density of the matrix of mitochondria and the increase in number of lysosomes, and finally there appeared the intranuclear chromatin condensation, further vacuolization of endoplasmic reticulum and swelling of mitochondria. During the process of recovery, the nucleus recovered first, the mitochondria next, the endoplasmic reticulum and lysosome last. The significance of these findings was discussed. (auth)

33042 OXIDATIVE PHOSPHORYLATION IN MITOCHONDRIA AND IN BRAIN HOMOGENATE OF X-IRRADIATED CHICKEN EMBRYO. Vatsadze, G. S.; Partshaladze, N. N. Soobshch. Akad. Nauk Gruz. SSR, 40: 339-42(1965). (In Russian).

It was shown that a sublethal dose of ionizing radiation does not exert an inhibitory influence on oxidative phosphorylation in mitochondria and in the brain homogenate of chicken embryo. However, a lethal dose of ionizing radiation which causes severe injury to the embryonic tissue does cause a decrease of oxidative phosphorylation. It is concluded that in the tissues of the irradiated embryo a decrease or the absence of oxidative phosphorylation is the result of atrophy or destruction of cells caused by irradiation. (BBB)

33043 THE EFFECTS OF 180-kv X RADIATION, Co γ RADIATION, AND 17-Mev FAST ELECTRONS ON LUNG TISSUE. Holsten, Dietrich Robert; Stender, Hans-Stephan (Univ., Marburg, Ger.). Strahlentherapie, 130: 34-42 (May 1966). (In German).

The radiation response of the lungs was investigated after local irradiation with 180-kv x rays, ^{60}Co γ rays, and 17 Mev electrons given as a 3000 R fractionated dose (6 × 500 R) with 3 day intervals. Histological studies were done 3, 6, and 9 weeks after irradiation. Pathological processes in the interstitium of the lungs were primarily observed. Type and intensity of the histological changes observed are about the same in all 3 kinds of radiation under the conditions used. However, the temporal course of the lung reaction seemed to be different. Tissue reactions caused by irradiation with 17 Mev electrons appeared and disappeared sooner than those caused by the other two kinds of radiation. (auth)

33044 REACTIONS OF LIVING TISSUES TO THE IMPLANTATION OF γ AND β IRRADIATORS (THORIUM DIOXIDE, ^{90}Sr AND ^{32}P). Unnewehr, Friedrich (Univ., Marburg, Ger.). Strahlentherapie, 130: 99-106(May 1966). (In German).

Methods for determining the tissue incorporation of ^{228}Th and ^{232}Th and their decay products are discussed. The storage of incorporated nuclides in tissues was investigated in animal experiments, using $^{90}SrNO_3$. Implantation of ^{32}P was used for studying tumor development caused by incorporated radionuclides. The problem of whether chronic irritation by the foreign body or ionizing radiation is the cause of malignant tumors in these cases was especially investigated. (auth)

33045 INFLUENCE OF SEED STORAGE AT HIGH TEMPERATURE AND INCREASED OXYGEN UPON THE MUTAGENIC EFFECT OF γ-RAYS. Shkvarnikov, P. K. Tsitologiya, 5: 535-45(1963). (In Russian).

The storage of seeds at high temperatures increases the mutagenic effect of preliminary and subsequent irradiation with γ rays. The storage of seeds at increased oxygen pressure after their irradiation with γ rays decreases the damaging effect of the latter or does not alter its essential effect. It was assumed that the effects of high temperature and increased oxygen pressure during the seed storage on the mutagenic changes in seeds exposed to radiation are both shown by the spontaneous mutation processes in the stored seeds, i.e., both temperature and oxygen affect the speed of accumulation and the nature of the chemical products of the metabolism of seeds having mutagenic properties. The interaction of these substances with products of the primary radiation depends on the nature of change of the radiation products The chemical assumed is obviously related to comparatively stable compounds. (tr-auth)

33046 STUDIES OF RAT'S THYROID AND HYPOPHYSIS FOLLOWING TREATMENT WITH VARIOUS DOSES OF RADIOACTIVE IODINE. Pantich, V.; Stoshich, N. (Inst. of Application of Nuclear Energy for Agriculture, Forestry and Veterinary Medicine, Zemun, Yugoslavia). Tsitologiya, 8: 17-23(Jan.-Feb. 1966). (In Russian).

Treatment of rats with ^{131}I induced some severe distortions in the thyroid cells: the form and size of the cells and the structure of nuclei underwent changing, the granular endoplasmic reticulum was reduced, some vesicles and cysternoid spaces with reduced amounts of RNA appeared, some osmiofilic substances showed their appearance in mitochondria and in vesicles of different size within the Golgi zone. All this may point to a much reduced ability of thyroid cells to hormonal synthesis and to their smaller proteolytic activity. The above changes were found within the first ten days following the injection of high doses of radioactive iodine (150 mC) and in 3–5 months following treatment with smaller doses (10 mC). ^{131}I treatment disturbed the differentiation of chromophobic γ-cells of the hypophysis, reduced the number of α-cells, caused degranulation of the latter as well as a change in their contents. The latter fact may account for the reduced ability of cells for growth hormone synthesis. Changes that accompany the thyrotropic β-cell hypertrophy may testify to the fact that the thyrotropic hormone synthesis increased in 5 months following the ^{131}I treatment (50 mC). However, at the same time the number of cells investigated revealed degenerative changes, so that a functional ability of the gland as the whole appears to be reduced. Changes of this kind were found in 3–5 months after treatment with low doses and in 10 days after the injection of 150 mC dose of ^{131}I. The changes observed in cells of the adenohypophysis and neurohypophysis may appear as a result of both direct and indirect (via the thyroid gland) effects of high doses of radioactive iodine. (auth)

33047 NUCLEAR PROCESSES AT CONJUGATION OF PARAMECIA FOLLOWING X-RAYS IRRADIATION. Kovaleva, N. E.; Jankowski, A. W. (Inst. of Cytology, Leningrad). Tsitologiya, 8: 80-9(Jan.-Feb. 1966). (In Russian).

Clones M_6 and M_{12} of Paramecium putrinum appeared to have different radiosensitivities. The survival of the paramecia of either clone within 4 days' x irradiation was 57 and 96%, respectively. Previous irradiation of paramecia caused a number of different disturbances in nuclear processes, both at conjugation of irradiated and unirradiated individuals and in case of conjugation of two irradiated individuals. The micronuclear division mechanism was disturbed judging from the abnormal form of spindles and a disoriented arrangement of chromosomes along the spindle. The interchange of migratory nuclei between two conjugants was abnormal too. The fusion of a migratory nucleus with a stationary one was very often incomplete. In some cases the migratory nucleus of one individual did not completely transfer into the other one, a part of the nucleus remaining in the former conjugant in the form of a tail. During the formation of the synkaryon other nuclei may join it, a very complex synkaryon being formed. The latter is capable of synthesizing DNA, but incapable of dividing. When the complex synkaryon divides, the products of its division either fuse in pairs or transfer into the other partner and join its nuclei. No visual morphological changes were observed in the macronucleus. (auth)

33048 RADIOMIMETIC ACTION OF ETHYLENIMINE ON JUTE. I. SOME MORPHOLOGICAL EFFECTS. Bose, Sunando; De, Anima (Bose Inst., Calcutta). Trans. Bose Res. Inst. (Calcutta), 27: No. 1, 13-24(Mar. 1964).

Seeds of jute (var. T.M.) were treated with different concentrations of ethylenimine (0.05 and 0.03%) and also with different doses of x rays (18,000 and 12,000 R) and their subsequent effects on growth and morphology were studied. It was found that there was a close similarity in effect between the x-ray and ethylenimine treatments. Thus both the chemical and x-ray treatments induced such leaf abnormalities as forked leaves, pitcher-shaped leaves (epiascidia), and various changes in the shape of the lamina in the affected plants. Stem abnormalities (bifurcation, fasciation) and flower abnormalities were also observed. Most of these types of stem and leaf abnormalities are known to be induced after x-ray treatment. Such similarity of action suggests that ethylenimine affects auxin synthesis in much the same way as x rays. (auth)

33049 PHYSICAL AND CHEMICAL FACTORS IN NUCLEAR EXPOSURE. Minder, W. (Eidgenoessische

Gesundheitsamt, Bern). Vierteljahresschr. Schweiz. Sanitaetsoff., 42: 30-6(May 1965). (In German).

The energy and radioactivity released in an atmospheric nuclear explosion are discussed. The frequencies of hydrocarbon derivatives produced by ionization are listed. The number and types of ionization reactions produced increase with the size of the original molecules. The role of water molecules in formation of ions is described. A small fraction (25%) of the radiation energy is not absorbed by water molecules, but by other substances that are involved in structure of organisms. However, the final effects of indirect ionization of water molecules and direct ionization of molecules are the same. The purpose of radiation protection agents is to prevent or correct for the ionizations produced in organisms. (TCO)

33050 DAMAGE FROM RADIATION EFFECTS TO THE EYE, ESPECIALLY BY LASER RADIATION. Fankhauser, Franz (Univ., Bern); Lotmar, Walter. Z. Angew. Phys., 20: 521-4(1966). (In German).

After a short survey of possible radiation damage to the human eye by x-rays, neutrons, infrared and microwaves the known facts about laser radiation damage are reviewed. Pertinent color filters for use in safety goggles are mentioned. Their protective power may be enhanced by evaporated interference films (selective reflectors). Finally some safety recommendations to be observed in laser work are enumerated. (auth)

33051 LACTIC DEHYDROGENASE AND RADIATION-INDUCED LYMPHOID LEUKAEMIA IN MICE. Takamori, Yasuhiko; Hori, Yasuharu; Nishio, Kazuo (Radiation Center of Osaka Prefecture). Z. Naturforsch., 21b: 352-7(Apr. 1966).

The enzyme activity and electrophoretic characteristics of lactic dehydrogenase (LDH) in the plasma and different tissues from mice with radio-induced lymphoid leukemia were examined and compared with those obtained from normal mice. The LDH activity was abnormally increased in the leukemic plasma. A considerable elevation of the enzyme level was also found both in the leukemic spleen and in the lymphocytes isolated from it, but not in the liver, kidney, heart, and muscle. LDH isozyme patterns were obtained by agar-gel electrophoresis. Each tissue exhibited a characteristic distribution of LDH activity among the separated isozymes. Leukemic plasma contained much more LDH-5 than normal plasma, showing the pattern similar to that obtained from leukemic spleen. Kidney and heart from leukemic mice indicated no difference in the LDH-patterns as compared with those from normal mice. (auth)

33052 DIFFERENT MUTATION SPECTRA OF DIFFERENT PURE LINES OF SIPPE 50 OF ANTIRRHINUM MAJUS L. AFTER THE SAME TREATMENT WITH X RADIATION. Linnert, Gertrud (Technische Univ., Berlin). Z. Vererbungsl., 98: 25-40(1966). (In German).

Three sub-lines of the old pure line "Sippe 50" of Antirrhinum majus were submitted to x radiation in order to find out whether the mutants arising from different lines form different mutation-spectra. From every sub-line 6–8 plants were pollinated, the pollen having being irradiated with a dose of 5000 R. Mutations were registered in X_2. Besides that seedlings of 14 randomly chosen X_2-progenies were irradiated a second time with 300 R. From them another generation was grown in order to gain even more mutations. So the families form a pedigree, the different branches of which represent the experimental units which had to be compared with each other. 8 series of phenotypically equal mutations, which arose independently from each other, were not distributed at random but accumulated within kindreds. In 4 cases coincidence was improbable, P ranging from 0.0001–0.003; 3 more mutant types occurred preferably within related strains, but according to P-values preference was not quite significant. Only one mutant-type was at random distributed among all progenies. Of 18 anthocyanin-deficient mutants 2 corresponded to the mutant nivea, the other 16 represented the incolorata-type. By diallelic crossing it was demonstrated that they are situated at 4 different loci. Two loci are concerned in mutations of the silvescens-type, two more in the small-leafed mutations. All the red-flowered mutations were allelic with each other, as well as the two serpentinas. The production of different mutation-spectra by different families of a pure line is explained. (P.C.H.)

33053 MECHANISM OF THE ORIGIN OF AUXOTROPIC CELLS IN HETEROZYGOUS SACCHAROMYCES STRAIN AFTER UV AND X IRRADIATION. Haefner, Klaus (Freie Univ., Berlin). Z. Vererbungsl., 98: 82-90(1966). (In German).

With a diploid Saccharomyces strain, heterozygous on nine chromosomes the process of irradiation-induced mitotic recombination was studied. The dose dependence of the recombination frequencies, measured by the amount of auxotrophic cells, was not linear after uv and x irradiation. These frequencies increased with centromeric distance of the gene tested, but recombination in centromeric neighborhood was more frequent, compared to meiotic distance than in centromeric far regions. — Pedigrees made from uv-irradiated cells always showed a reciprocal recombination mechanism, but irradiation induced recombination seemed not to be restricted to the first generation after irradiation, it occurred in later generations too. (auth)

33054 EFFECTS OF BLEEDING ON THE ABSORBING CAPACITY OF RETICULO–ENDOTHELIAL SYSTEMS IN ANIMALS EXPOSED TO LETHAL DOSES OF X IRRADIATION. Magakyan, A. G. Zh. Eksp. Klin. Med., 6: 72-9(1966). (In Russian).

Bleeding, produced in intact rabbits (in a volume of 30% of the total blood mass), caused a stimulation of the RES absorbing function. During serious radiation sickness, the absorbing function was depressed. The application of two stresses (irradiation and bleeding) simultaneously led to even greater depression of the absorbing function. (tr-auth)

33055 ON THE BIOLOGICAL EFFECT OF HIGH ENERGY PROTONS, FISSION NEUTRONS, γ- AND X-RADIATIONS (ON ANIMALS). Konoplyannikov, A. G.; Kudryashov, Yu. B. (Moscow State Univ.). Zh. Obshch. Biol., 27: 145-62(Mar.-Apr. 1966). (In Russian).

Studies were carried out in relation to various manifestations of radiation damage of animals irradiated by different values of the linear energy transfer (LET). Dependence of the survival level of mice upon various types of doses of ionizing radiation was established. The LET value dependent coefficients of the relative biological efficiency (RBE) of the radiations were calculated according to the equation: RBE $\approx 0.7 + 0.06$ LET. The RBE value was empirically determined by the survival level of animals. As a standard radiation type with the RBE-1 therapeutic x rays were used. The LET value was calculated in kev/μ. Investigations were performed to reveal changes in the weight of the animal and some organs, the blood picture, erythrograms, alterations in the level of autolysis, lipid metabolism, formation of lipid radiotoxins (natural radiomimetic), dynamics of changes in reparative processes, and the so-called residual damage of animals irradiated at doses causing equal survival. A uniform reaction of the organism in response to different types of ionizing radiation was found, However, a rise of the LET caused a greater difference between radiosensitive and radioresistant organs. Doses of different ionizing radiations equivalent in their effect (300, 700 and 1500 rbe) seemed to produce the same damage of the bone marrow and a greater intestinal damage for radiations of high density. It is suggested that the state of increased radioresistance is associated with that of the hyperfunction of radiosensitive organs, particularly of hemopoietic ones, which develops as a result of reparative processes. (auth)

33056 MECHANISM OF CHANGES IN THE FUNCTIONAL STATE OF THE CENTRAL NERVOUS SYSTEM IN IRRADIATED ANIMALS (THE ROLE OF BLOOD CIRCULA-

TION). Lyubimova-Gerasimova, R. M. pp 21-35 of Patogenez, Eksperimental'naya Profilaktika i Terapiya Luchevykh Porazhenii. Lebedinskii, A. V. (ed.). Moscow, Izdatel'stvo Meditsina, 1964. (In Russian).

A total of 15 rabbits was given an x ray dose of 1000 R. The bioelectrical activity of the cortex and the volume blood flow were determined by a flat electrode fastened to the skull. The labyrinth response was tested by subjecting the animal to an angular velocity of 30, 60, and 120°/sec, and then stopping the equipment within 0.15 sec so as to obtain an acceleration of 200, 400 and 800°/sec^2, respectively. A decrease in blood volume flow and also a decrease in the cortical biopotentials were observed in the later stages of radiation sickness. A 30-second compression of one of the carotid arteries served as a vascular probe of the brain biopotential. This test indicated an insufficiency in blood circulation and the development of brain hypoxia. The irradiated animals showed a decrease in reactivity of the vestibular apparatus. The number of functioning blood vessels decreased and the intercranial pressure fell. The central nervous system became functionally disabled, and lost its reactivity. Waves appearing in the cortex with vestibulary stimulation stopped appearing. The decrease in blood flow was related to the decrease in excitability of the cortical nerve cells. (TTT)

33057 CHANGES OF THE INTEROCEPTIVE ANALYZER SYSTEM IN ANIMALS EXPOSED TO LOCAL X IRRADIATION. Delitsyna, N. S. pp 39-46 of Patogenez, Eksperimental'naya Profilaktika i Terapiya Luchevykh Porazhenii. Lebedinskii, A. V. (ed.). Moscow, Izdatel'stvo Meditsina, 1964. (In Russian).

Rabbits were given a partial-body x ray dose of 1000 or 3000 R to the head, stomach, or spinal cord in the thoracic region. Electrodes were attached to the animals at the hypothalmus, and at the front, back and side of the cortex. Interoceptive stimulation was carried out by filling up a rubber balloon with 150 ml of water after its introduction into the rectum. Light of increasing brightness was also used as a stimulant. A dose of 1000 or 3000 R to the head gave an increase in the bioelectrical activity of the cortex within one day. The activity in the cortex and hypothalmus then decreased. Most of the animals died on the 2nd to 14th day after irradiation. Similar changes were observed on using a dose of 3000 R to the stomach or spinal cord. (TTT)

33058 INACTIVATION OF NEWCASTLE DISEASE VIRUS BY THE DISINTEGRATION OF INCORPORATED RADIOACTIVE PHOSPHORUS AND BY PHOTODYNAMIC INACTIVATION OF THE ACRIDINE ORANGE-STAINED VIRUS. Frank, Glynn Henry. Athens, Ga., Univ. of Georgia, 1965. 59p.

Thesis.

Newcastle disease virus was inactivated by two different methods not used previously. Radioactive phosphorus (^{32}P) was incorporated into the viral nucleic acid. During storage of the virus, the ^{32}P disintegrated, thus breaking and inactivating the nucleic acid molecule. Virus was stained with acridine orange (AO), a nucleic acid-specific dye. Upon subsequent exposure to light, the viral nucleic acid was photodynamically inactivated. Theoretically, by both of these methods, the viral nucleic acid was inactivated while the protein capsid remained unchanged. An experiment to test the immunizing ability of the photodynamically inactivated virus indicated that the virus was not immunogenic by itself. (Dissertation Abstr.)

33059 BIOLOGICAL EFFECTS OF RADIATION. Abdel-Bari, Waguih Mohamed. St. Louis, Washington Univ., 1965. 162p.

Thesis.

Adult male Sprague-Dawley rats were exposed to 600 R whole-body x irradiation. At different intervals following radiation the spleen was removed and the ultrastructural alterations associated with splenic recovery were studied. In the second series, rats were injected with 10 μC/g body wt. ^{3}H-thymidine intraperitoneally at various intervals following irradiation. Spleen, thymus, and small intestine were removed; sections were cut and prepared for light and electron autoradiography. In the third series, rats were divided into 2 groups. Rats of Group 1 were injected with 1% sheep red blood corpuscles intravenously; at different intervals following antigen injection they were exposed to 600 R whole-body x irradiation. Rats of Group 2 were first exposed to x irradiation, and then injected with the antigen at various intervals following irradiation. Hemolysin antibody was titrated in serum of both groups. The recovery process in the spleen following irradiation of rats consisted of removal of the cellular debris by active phagocytic cells, which was complete by 24 hours after irradiation. Proliferation of plasma cells occurred three days after irradiation and reached a peak at one week. Compensatory extramedullary hematopoiesis was maximal at 2 weeks after irradiation at which time erythroblasts in various stages of development were scattered within the red pulp. The number of megakaryocytes was at a peak 3 weeks after irradiation. Repopulation of lymphocytes began 1 week after irradiation and was complete by 3 weeks. Light and electron autoradiographic studies were consistent with the derivation of splenic lymphocytes from reticular cells, but did not conclusively rule out other possibilities. The thymus and intestine were excluded as a source of repopulation of the spleen following irradiation. Whole-body irradiation in rats inhibited hemolysin antibody synthesis whether the rats were exposed to radiation before or after antigen injection. However, the degree of inhibition was nearly complete when the rats were exposed to irradiation before antigen injection. (Dissertation Abstr.)

33060 EFFECT OF X RAYS OF DIFFERENT DOSES ON CYTOCHEMICAL AND BIOCHEMICAL CHANGES IN RABBIT TISSUES. (COMMUNICATION 2). Volovik, M. P.; Gorina-Rabinovich, L. M., Odaryuk, V. A.; Chursina, V. K. pp 11-15 of Sb. Voprosy Genetiki i Zoologii. Karkov, Karkovskii Univ., 1964. (In Russian).

With the aid of cytochemical and biochemical methods an investigation was made of the effect of x irradiation (450 and 900 R) on the nucleus and cytoplasm of cells of the rabbit liver and the gastric mucosa on the 1st, 5th, 10th, 15th, and 30th day after exposure. It was shown that with both doses on the 5th day and especially on the 10th day decreases occurred in the quantity of chromatin in the nucleus, with a decrease in amount of DNA. The cytochemical data were confirmed by chemical determination of DNA. At the same time in cytoplasm it was possible to observe a rise in basophilia which coincided with increase of RNA concentration. This was also confirmed by the direct determination of RNA by biochemical methods. On the 30th day the histochemical and biochemical results indicated that the DNA and RNA contents were almost returned to normal. (BBB)

33061 CURRENT TOPICS IN RADIATION RESEARCH. VOLUME II. Ebert, Michael; Howard, Alma (eds.). Amsterdam, North-Holland Publishing Company, 1966. 404p. $12.60.

Seven chapters are included; separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual papers see: 32935, 32936, 33062, 33063, 33113, 33346, and 33347.

33062 APPROACHES TO THE DETERMINATION OF THE INITIAL SITES OF ACTION OF RADIATIONS IN ESCHERICHIA COLI AND YEAST. Joset, F.; Moustacchi, E.; Marcovich, H. (Institut du Radium, Paris). pp 249-78 of Current Topics in Radiation Research. Vol. II. Ebert, Michael; Howard, Alma (eds.). Amsterdam, North-Holland Publishing Company, 1966.

Results obtained with microorganisms, essentially E. coli and yeast, using the techniques of genetics to analyze, by conjugation between two cells, the damage produced by radiation are discussed. The mechanism of x-ray and uv-induced lethal and mutagenic effects in E. coli, at the intracellular level are first considered, and secondly the genetic aspects of radiosensitivity in yeast. The mutagenic action of radiation in E. coli was found to be a direct modification of the genetic locus when x rays are used, and a cytoplasmic mediated one after uv irradiation.

The results on yeast indicated a correlation between radioresistance and excess RNA. Protein synthesis also seemed to have an important role in transitory radioresistance. (66 references). (P.C.H.)

33063 RADIOPATHOLOGY OF EXTRACELLULAR STRUCTURES. Brinkman, R.; Lamberts, H. B. (Univ. of Groningen, Netherlands). pp 279-302 of Current Topics in Radiation Research. Vol. II. Ebert, Michael; Howard, Alma (eds.). Amsterdam, North-Holland Publishing Company, 1966.

A review is presented on: water permeability of subepidermal membranes; intradermal injection pressure; outer layers of the erythrocyte cell wall; enzyme liberation; the importance of matrix mucopolysaccharide damage; radioinduced chemical changes in synovia and in hyaluronic acid; and ozone as a radiosensitizer. (46 references). (P.C.H.)

33064 BIOLOGICAL EFFECTS OF X-RAYS AND ALKYLATING CHEMICALS ON LAKOTA DURUM. Edwards, Lewis Hiram. Fargo, N. D., North Dakota State Univ., 1965. 67p.

Thesis.

Seeds of Lakota durum were treated with x rays and three chemicals: Seeds with 16% moisture content were irradiated with doses of 7.5, 15.0, 22.5, and 30.0 kR in 1962, and doses of 15.0 and 22.5 kR in 1964. In 1962, seeds were treated for 30 and 60 minutes with 0.26% DS, 60 and 90 minutes with 3.0% EMS, and 30 minutes with 0.1% EI, or 60 minutes with 0.05% EI. In 1964, all treatment durations were 24 hours in length. Chemical concentrations were 0.008 and 0.02% for DS, 0.5 and 1.0% for EMS, and 0.02 and 0.03% for EI. In 1962, spike fertility was significantly reduced by the more severe treatment with EMS and by the 22.5 and 30.0 kR treatments with x rays. In 1964, only the 0.5% EMS treatment significantly reduced spike fertility (28.0%). The 1.0% EMS-treated material did not survive under field conditions in 1964. High mutation frequencies induced by DS and EMS were not accompanied by high frequencies of chromosomal aberrations. Conversely, x rays produced high frequencies of chromosomal aberrations and relatively low frequencies of mutations. The high sterility observed in the EMS-treated material appears to be due to small intrachromosomal or genic changes rather than gross chromosomal aberrations. Much of the sterility observed in the x-ray-treated material may be associated with chromosomal aberrations. Differences were found between the mutation spectrum induced by the alkylating chemicals and the spectrum induced by x rays. The chemicals induced a lower frequency of albina and higher frequencies of viridis and rare mutants than x rays. (TCO)

33065 X-RAY SURVIVAL KINETICS OF RANDOM AND SYNCHRONOUS POPULATIONS OF MAMMALIAN CELLS GROWN IN VITRO. Phillips, Robert Allan. St. Louis, Washington Univ., 1965. 127p.

Thesis.

In an attempt to elucidate the cellular target whose inactivation by x ray results in cell death two phenomena were examined. The first was the sensitivity increase observed when cultured mammalian cells are irradiated at increasing times after trypsinization. It was found that cultures of HeLa S3 cells grown for three days in a standard growth medium show a rapid drop in sensitivity to x rays immediately after trypsinization. They subsequently undergo a further transient decrease in sensitivity lasting about one day, before slowly returning to the pretrypsinization level of sensitivity about two days later. If grown in a medium lacking human serum but otherwise identical to the usual medium, only the transient sensitivity change is observed. The fluctuations in sensitivity would appear to arise, at least in part, from a redistribution of cells among the various sensitivity states characteristic of the different periods of the cell cycle. The second phenomenon studied was the gradual increase in radiation sensitivity that occurs during the pre-DNA-synthesis period (G_1) in HeLa S3 cells. It was found that postirradiation incubation of the cells in the presence of inhibitors of DNA synthesis significantly decreases the number of surviving cells; this effect is demonstrable throughout all of G_1. Post-irradiation incubation of the cells in the presence of an inhibitor of protein synthesis, cycloheximide, increases the number of surviving cells; cycloheximide is much more effective in late G_1 than in early G_1. These two results were interpreted as indicating that cells normally repair a fraction of the radiation damage in DNA, and that the amount of repair the cells are able to complete gradually decreases as cells progress through G_1. It is suggested that DNA inhibitors decrease cell survival by inhibiting the repair process, while cycloheximide delays the onset of DNA synthesis, thereby providing extra time for the cells to repair radiation-induced damage. The These results provide additional evidence that DNA is the sensitive target, damage to which results in cell death. (TCO)

33066 RADIOBIOLOGICAL STUDIES OF GENE FUNCTION IN BACTERIOPHAGE T4. Wallace, Susan Scholes. Ithaca, N. Y., Cornell Univ., 1965. 145p.

Thesis.

Experiments were undertaken to study the effect of x rays on genetic function, to compare this effect with that of ultraviolet light, to relate radiobiologically defined gene function to biochemical gene function, to elucidate the meaning of radiation lethality as applied to bacteriophages and to evaluate the radiation survival of a single gene in terms of lethality. The T4 amber conditional lethal system was used. The survival of the amN82+ gene in cistron 44 was measured. The survival of amN82+ as a function of ultraviolet dose was markedly affected by filtering the output of the germicidal lamp with a glacial acetic acid filter. For the x-ray studies, the wild-type phage was x irradiated inside the nonpermissive host E. coli B. These complexes were then superinfected with the amber mutant and the survival of cistron 44 gene function measured by plating on the indicator strains. For other experiments the bacteria were pretreated with 25 μg/ml of chloramphenicol. A model for phage radiation inactivation was proposed to account for the results obtained. Two types of radiation damages were proposed: replicative and functional. Replicative damages are those that prevent the formulation of new and complete copies of the DNA. The target for replicative damages is the whole phage genome. Functional damages are those that inhibit the formation of effective message RNA. The targets for functional damages are the operons, or units of function. The target for lethal functional inactivation of the free phage or early complexes is the coding strand of an operon, which directly pertains to DNA synthesis. If the phage is irradiated after this information has been transcribed into message RNA, damage to the operon is no longer measured. Other phage radiobiological phenomena are explained in terms of this model. (TCO)

33067 BACTERIOPHAGE ΦX-174: ITS SENSITIVITY TO ULTRAVIOLET LIGHT AND GROWTH IN STARVED AND IRRADIATED CELLS. Yarus, Michael Jeffrey. Pasadena, Calif., California Inst. of Tech., 1966. 169p.

Thesis.

Ultraviolet action spectra for inactivation of ΦX-174 virus, its infective single-stranded DNA (SS), and an infective, intracellular, and presumably double-stranded DNA (RF) were determined. The biological activity of the irradiated DNA was measured using bacterial protoplasts. The inactivation cross section of the RF is nearly an order of magnitude less at all wavelengths than that of either the free single-stranded DNA or the intact virus which have very similar cross-sections. Besides the difference in magnitude, the action spectrum of RF, when compared to that of SS ΦX DNA shows several differences in band shape. The ability of ΦX bacteriophage-infected cells to release progeny after uv irradiation was examined using both a host possessing host cell reactivation (E. coli C_N) and one lacking it (E. coli C_s). The burst of a starved bacterium infected with several ΦX174 bacteriophage is usually found to contain descendants of only one of the parents; less often, two phage may multiply. Unstarved cells can support the growth of at least four phage.

The unproductive phage seem to convert their parental single-stranded DNA into intracellular, double-stranded RF. These results are interpreted to mean that some factor required by ΦX for the production of progeny is limited in starved cells. Evidence is presented that starved, uv-irradiated E. coli C that has lost its capacity to support ΦX bacteriophage reproduction has also become unsuitable for the synthesis of infective RF, though the incoming single-stranded viral DNA is able to undergo the transition to an RF whose behavior on neutral density gradient analysis is the same as normal RF. Very alkaline conditions appear to activate the inactive RF, releasing infective parental single strands as well as making infective those RF whose strands do not separate. (TCO)

33068 EFFECT OF WHOLE-BODY GAMMA, NEUTRON, AND GAMMA-NEUTRON IRRADIATION ON ORGAN WEIGHTS IN THE MOUSE. Majors, Rias Hilton. Athens, Ga., Univ. of Georgia, 1965. 74p.

Thesis.

The direct and transmittable effects produced by two sublethal dose levels of gamma and neutron radiations and two sublethal dose levels of gamma-neutron combination radiations (administered separately) on adrenal, spleen, and testes weights were studied. Mice of the BALB/cJ strain were used. Males were irradiated and mated to their non-irradiated sisters 7–12 days post irradiation and again 8 weeks post irradiation. This procedure was repeated for six generations. Data were collected and analyzed on 781 sires, 437 male progeny, and 419 female progeny. There was no histological evidence that the glands from the irradiated sires and their progeny differed from the glands from the control sires and their progeny. Statistical analysis of the adrenal mean weights of sires revealed that none of the treated means differed significantly from the control mean. Statistical analysis of the testes weights revealed a highly significant ($P < .01$) treatment effect and a nonsignificant generation effect. The high level combination radiation treatment was most effective and the neutron treatments were least effective in reducing testes weight. This indicates that the assumed neutron RBE of 10 was in error insofar as effect on the testes is concerned. There was no evidence to indicate that any heritable changes in testes weight were induced by irradiation. Analysis of variance of the gland weights of progeny showed a non-significant treatment effect ($P < .01$) on adrenal weights but showed a significant treatment effect on spleen weights. There were highly significant ($P < .01$) sex effects on adrenal and spleen weight of progeny (females heavier). There were highly significant ($P < .01$) generation effects on all gland weights of sires, progeny, and combination of sires and progeny except for testes weight of sires and spleen weight of progeny. It is biologically significant that there were no statistically significant weight changes in adrenals or spleens of irradiated sires, or if there were these organs were able to recover in the 9 weeks post irradiation period. (TCO)

33069 EFFECTS OF X-IRRADIATION ON THE RAT, MOUSE, AND HAMSTER TESTES AND THE SURVIVAL OF AUTOGRAFTS AND HOMOGRAFTS OF UNIRRADIATED TESTICULAR TISSUE INTO THE IRRADIATED TESTES OF THE MOUSE AND HAMSTER. Leach, Eddie Dillon. College Station, Tex., Texas Agricultural and Mechanical Univ., 1965. 104p.

Thesis.

The testes only of the rat, mouse, and hamster were given acute doses of x irradiation using a dose rate of 37 R/minute. The mouse testes received either 900, 1,200 or 1,500 R; the rat testes received either 1,200, 1,500, or 1,800 R; and the hamster testes received either 1,200, 1,650, or 2,100 R. The testes of each species were removed at various intervals postirradiation and histological analyses were made with respect to the degree of sterilization. It was found that 1,200 R was insufficient to sterilize all the testes of the rat and hamster for intervals of 42-261 days postirradiation. Doses of 1,500 and 1,800 R sterilized the rat testes through the 261-day duration of the experiment; and doses of 1,650 and 2,100 R sterilized the hamster testes through the 235-day duration of the experiment. None of the doses administered were sufficient to sterilize the mouse testes. Transplants of unirradiated seminiferous epithelium were made into the irradiation-sterilized testes of the mouse and hamster. The isografts in the mouse consisted of segments of unirradiated seminiferous tubules suspended in a saline solution and injected into the extra-tubular space of the irradiated testes. The results indicated that regeneration of spermatogenesis occurred in the irradiation-sterilized tubules of the host testis. In the irradiated hamster testes autografts of segments of seminiferous tubules into the extra-tubular space of the irradiation sterilized testes resulted in the recovery of active tubules in the testes removed at various intervals post-transplantation. Autografts of disrupted segments of unirradiated seminiferous tubules into the extra-tubular spaces of the irradiation sterilized testes produced fewer successful grafts and was correlated with the fewer tubule segments injected. No spermatozoa were observed in the epididymides of the testes. Autografts and homografts of a tissue-free, cellular suspension into the tubules of the irradiated testes showed no recovery of spermatogenesis or spermatogenic activity of any kind in any of the testes that received transplants. The irradiated testes that did not receive transplants remained completely sterile. (TCO)

33070 EFFECT OF ULTRAVIOLET IRRADIATION ON THE UPTAKE OF TRITIUM-LABELED THYMIDINE IN CHINESE HAMSTER CELLS (IN VITRO). Phelps, Harriette Longacre. Columbus, Ohio, Ohio State Univ., 1965. 49p.

Thesis.

Chinese hamster (Cricetulus griseus) cells in cell culture were studied to determine the effects of ultraviolet radiation primarily at 2537 Å on thymidine incorporation and the cell cycle. The effects were investigated by using tritiated thymidine uptake with autoradiography. Doses ranged from 26 ergs/mm^2 to 143 ergs/mm^2 and corresponding cell survival ranged from 100 percent to 37 percent. Ultraviolet radiation up to 80 ergs/mm^2 (90% survival) caused a half-hour mitotic delay in cells irradiated in G_2 phase, a one hour mitotic delay in cells irradiated in G_1 phase, and a mitotic delay in cells irradiated in S phase that increased with increasing dose. There was an increase in both the average length of S phase and in the variation among cells in length of S phase with increasing dose. After irradiation the mitotic index dropped rapidly. Return of the mitotic index to normal was gradual and faster with lower doses. Also after irradiation the percentage of cells incorporating tritiated thymidine rose rapidly from the control average of 66 percent to around 90 percent. The percentage of labeled cells returned gradually to normal with the speed of recovery varying inversely with dose. Irradiation caused the average grain count per labeled cell to fall to a minimum of about 25 percent of normal at one and one-half hours after irradiation. The recovery of grain count was very gradual and faster for lower doses. The reactions to ultraviolet radiation were basically similar in the case of total cell recovery and for degrees of cell killing up to 63 percent. One difference with total cell recovery was that the reactions to ultraviolet radiation damage started more rapidly and were less extreme. A major difference seen with higher doses was the increase in mitotic delay of cells irradiated in S phase. (TCO)

Radiation Effects Therapy and Countermeasures

Refer also to abstract 33049.

33071 PATHOLOGIC ALTERATIONS OBSERVED IN RHESUS MONKEYS GIVEN TOTAL-BODY X-IRRADIATION AND BONE MARROW TRANSPLANTS. Allen, J. R.; Hall, A. S.; Chesney, C. F. (Univ. of Wisconsin, Madison). Amer. J. Vet. Res., 27: 1103-12(July 1966).

Thirty-one Macaca mulatta monkeys were given 700 to 800 R whole body x irradiation. Bone marrow transplants from homologous and heterologous sources were administered to 24 of the monkeys. Regeneration of hematopoietic tissue occurred in more than 60% of the 24 monkeys given transplants; however, only 20% survived for 30 days. There were extensive hemorrhage, anemia, leukopenia, thrombocytopenia, hypergammaglobulinemia, and bacteremia in the monkeys that died. The death of those monkeys that died during the 2nd and 3rd postirradiation weeks was attributed to the inability of their defense mechanisms to prevent rapid multiplication of enteric organisms within their tissues. The monkeys invariably died with massive gram-negative bacteremia. (auth)

33072 AET AND RADIATION-INDUCED CROSSING-OVER IN MALE DROSOPHILA MELANOGASTER. Mittler, Sidney (Northern Illinois Univ., De Kalb). Biol. Bull., 130: 228-34(Apr. 1966).

Drosophila melanogaster males heterozygous for ru h th st cu sr e^8 ca were injected with AET and x irradiated with 2000 R and backcrossed to rucuca. The number of induced crossovers with two or more mutants (r_2) was significantly decreased in the 9 to 12-day broods of males treated with AET as compared to controls. The hypothesis that AET interfered with a recovery process probably by an induced anoxia was tested by N_2-treatment after the x-ray treatments. The N_2 post-treatments had no effect on AET-treated and irradiated males with respect to crossovers; however, the young spermatogonia represented by brood day 12 to 15 of the control males were induced by the N_2 treatment to produce less crossovers. Since the AET effect is eliminated by N_2 post-treatment, an anoxia production by AET can be a possible mechanism for reduction of crossovers. Nitrogen post-treatment tends to reduce the number of radiation-induced crossovers. AET did not affect the young spermatogonia. The induced breakage occurred primarily between regions st and cu and thus in or about the centromeric region. AET has no influence on the region of the breakage. (auth)

33073 MODIFICATION OF HEMATOPOIETIC CELL TRANSPLANTATION IN MICE IRRADIATED WITH GAMMA RAYS UNDER HIGH DOSE RATE. I. COMBINED USE OF AET AND BONE MARROW TREATMENT. Adachi, Kazushige (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 44: 89-102(Jan. 1966).

AET protected mice supralethally irradiated with gamma rays under high dose rate were treated with isologous bone marrow (IBM) or homologous bone marrow (HBM). The combined use of AET and IBM was effective for saving the mice exposed to supralethal irradiation, but most of the AET protected and HBM treated ones died after the 21st post-irradiation day. The AET protected and gamma-irradiated donor HBM could not prevent delayed death. (auth)

33074 MODIFICATION OF HEMATOPOIETIC CELL TRANSPLANTATION IN MICE IRRADIATED WITH GAMMA RAYS UNDER HIGH DOSE RATE. III. ALTERATION OF MIDLETHAL DOSE KILLING EFFECT. Adachi, Kazushige (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 44: 117-22(Jan. 1966).

Midlethal dose killing effect of gamma radiation at high dose rate in mice was altered by preimmunization, homologous spleen cell transplantation, passive transfer of antiserum, and transplantation of chimeric donor. (P.C.H.)

33075 RADIATION PROTECTION OF SHIGELLA FLEXNERI BY COMPOUNDS CONTAINING THE THIOUREA MOLECULAR STRUCTURE. Cramp, W. A. (Hammersmith Hospital, London). pp 153-9 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

The protective abilities of several thioureas were investigated by adding them to M/15 phosphate buffer solution of Shigella flexneri Y6R prior to irradiation of the suspensions with an electron beam under various conditions of dose rate, temperature, and atmosphere. Typical survival curves with various thioureas exhibit the same general shape, but direct comparison of effect, compound to compound, was difficult over a wide concentration range. Of the compounds tested, thiourea and thiosemicarbazide were the most effective compounds, and possible mechanisms for their protective action are suggested. (B.L.M.)

33076 EFFECT OF CYSTEAMINE ON FREE-RADICAL REACTIONS IN IRRADIATED COMPOUNDS OF BIOLOGICAL INTEREST. Baker, A.; Ormerod, M. G. (Royal Military Coll. of Science, Shrivenham, Eng.). pp 160-4 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

The effects of cysteamine and oxygen on the free-radical reactions in irradiated freeze-dried cells of Escherichia coli B/r were observed. A hypothesis based on the results is reported to explain the observed difference in the degree of protection given by sulfhydryl compounds in the presence and absence of oxygen in different systems. Only a brief summary of results is presented. (B.L.M.)

33077 EFFECT OF THYMECTOMY ON IMMUNE RESPONSE IN ADULT RATS. Csaba, G.; Dunay, C.; Fischer, J. (Univ. Medical School, Budapest. Mathematical Inst., Budapest). Experientia, 22: 253-4(1966).

The effects of age and time elapsed since thymectomy on immune response in adult rats were studied. Whole-body x irradiation of thymectomized adult rats reduced the immune response below that of the unimpaired controls, provided the antigenic stimulation was repeated. Such reduction was, however, neither durable nor did it occur in all age groups. In general, the length of time elapsed since the removal of the thymus affected the immune response more than the age of the thymectomized animal. (P.C.H.)

33078 EFFECT OF PROTECTIVE SUBSTANCES ON INACTIVATION OF BACTERIOPHAGE DURING X IRRADIATION. Hradecna, Zdenka; Toufarova, Danuse (Inst. of Biophysics, Brno). Folio Biol. (Prague), 12: 124-31 (1966).

The effect of x irradiation on the inactivation of lambda phage in the presence of protective substances was studied. Cysteamine, AET (2-aminoethylisothiouronium bromide hydrobromide), glycerin, ascorbic acid, ethyl alcohol, and sodium chloride were used. Glycerin and 1 M cysteamine gave the greatest protective effect. The role of oxygen was also studied; it was found that the oxygen effect was not manifested during irradiation of lambda phage. An increase in the radioresistance of the phage was recorded in anoxia only in the presence of cysteamine, AET, and ascorbic acid. The mechanism of the protective effect of the above substances is discussed with reference to various recent hypotheses. (auth)

33079 INFLUENCE OF 2,4-DINITROPHENOL (DNP) ON MUTATION FREQUENCY IN SPERM CELLS AND SPERMATIDS OF DROSOPHILA IRRADIATED WITH GAMMA RAYS. Abeleva, E. A. (Inst. of Biological Physics, Moscow). Genetika, No. 1, 116-18(Jan. 1966). (In Russian).

Studies showed that DNP treatment decreases frequency of recessive sex linked lethal mutations in γ-irradiated Drosophila spermatids at a dose of 1000 R. It is significant that in sperm cells of the same flies mutation frequency did not change. (P.C.H.)

33080 ACTION OF THE FLUORESCENT DYE, ACRIDINE ORANGE, ON RADIATION-INDUCED LEUKOCYTOSIS IN MICE. Sukhatankar, Jayashree V.; Korgaonkar, K. S. (Indian Cancer Research Centre, Bombay). Int. J. Cancer, 1: 297-303(May 15, 1966).

The action of the fluorescent dye, acridine orange, which is known to bind selectively to nucleic acids in cells, was tested on radiation-induced leukemia in mice. The toxic effect of different doses of the dye for the animals was determined, as was the whole-body x radiation dose that induced leukemia in the animals. Irradiated animals developing this disease were injected with a single dose of acridine orange (0.3 μg/20 g body weight) 30 or 45 days after irradiation. In both cases the blood picture, extended

life-span of the animals, and histological examination of the tissues after such treatment indicated a strong inhibitive action of acridine orange on the incidence of radiation-induced leukemia. (auth)

33081 PROTECTION BY BLOOD SERUM AGAINST EPILATION OF MOUSE BY X RAYS. Van Caneghem, P.; Beaumariage, M. L.; Lachapelle, J. M. (Univ., Liege. Univ. Louvain, Belg.). Int. J. Radiat. Biol., 10: 43-50 (Feb. 3, 1966). (In French).

It was confirmed that a trauma as light as the introduction of a thin needle into the skin of a young mouse is enough to give protection of the area against epilation by x rays. Assuming that this protection is due to an extravasation of blood, it was found that protection by the blood is mainly due to a liberation of 5-hydroxytryptamine from the thrombocytes. The part played by other vasoactive substances which may be liberated by the coagulation seems negligible. Distilled water provides protection of the haircoat by injuring the skin cells. Certain macromolecules not endowed themselves with a radioprotective power diminish the protective effect of the serum, probably by impeding its diffusion. (auth)

33082 EXPERIMENTS ON THE MECHANISM OF THE RADIOSENSITIZATION OF CELLS BY 2-METHYL-1,4-NAPHTHAQUINOL BIS (DISODIUM PHOSPHATE). Gronow, M. (Cambridge Univ., Eng.). Int. J. Radiat. Biol., 10: 103-6(Feb. 3, 1966).

Studies were made on the radiosensitivity of the quinone thioether link both in a model system and in mouse ascites tumor in vivo. For use as a model system, tritiated menadione was reacted with thiolated Sephadex. Studies on the water soluble substances showed that the thioether bond was very sensitive to light (15% and 30% destroyed after 2 hr and 24 hr, respectively when exposed to daylight). However, when the menadione Sephadex (suspended in 0.15 M phosphate buffer pH 7.4) was irradiated with doses of up to 300 krads of x irradiation from a 14 Mev linear accelerator, virtually no thioether links were broken. Also no changes in –SH levels were detectable in experiments on the effects of 1000 rads of 14 Mev x irradiation from the linear accelerator (delivered in 1 min) on mouse ascites tumor in vivo 30 min after administration of a dose of tritiated 2-methyl-1,4-naphthalenediol bis(disodium phosphate). The mechanisms involved are discussed. (P.C.H.)

33083 COMPARISON OF THE RADIOSENSITIVITY OF IMMUNOLOGICALLY COMPETENT CELLS PARTICIPATING IN GRAFT-VERSUS-HOST REACTION BEFORE AND AFTER CONTACT WITH THE ANTIGEN. Mathe, G.; Amiel, J. L. (Hopital Paul-Brousse, Villejuif, France). Contracts 32-64-1-BIO F; 61(052)816. Int. J. Radiat. Biol., 10: 107-10(Feb. 3, 1966).

Studies were made on the radiosensitivity of immunologically competent cells that react against histocompatibility antigens, before and after they have been in contact with these antigens. The reaction of a graft of lymph-node cells against an irradiated semi-allogenic host was used as the test system in the experiments. Mice F1 (C57B1/6 × DBA/2) were irradiated with 500 rads and then given a transfusion of 10^7 bone marrow cells from adult C57B1/6 donors of the same sex. They were then divided into 2 sub-groups (Group A and Group B). Group A mice were each given 2.5×10^7 lymph-node cells from irradiated C57B1/6 donors. Group B mice were given 2.5×10^7 lymph-node cells from F1 (C57B1/6 × DBA/2) irradiated donors. The results showed that the cells injected into the animals in group B were less effective in causing a lethal secondary syndrome than the cells used for the group A mice. (P.C.H.)

33084 TRANSPLANTATION OF THE DONOR BONE MARROW IN A COMPLEX TREATMENT OF PATIENTS WITH RADIATION SICKNESS SECONDARY TO RADIATION THERAPY. Bogoyavlenskaya, M. P.; Sukasyan, G. V.; Vinograd-Finkel, V. R.; Rodina, R. I.; Krasyukova, L. I. (Inst. of Hematology and Blood Transfusion, Moscow). Med. Radiol., 11: No. 1, 15-23(Jan. 1966). (In Russian).

Clinical applications of homologous bone marrow in the treatment of patients presenting marked manifestations of hemopoietic depression consequent to radiation treatment of cancers are discussed. The observations concern 7 patients who received 11 transfusions of bone marrow. The bone marrow transfusion technique and clinical effects thereof are described. No complications ensued after transfusions. Stabilization of the peripheral blood indices sets in within periods from 3 to 8 weeks after transfusion. At this time the bone marrow presents the picture of a growing number of nucleated cells, normalized leuko-erythroblast ratio and maturing of the components, less manifest changes of megacaryocytes, reduced number of nondifferentiated elements and of plasmatic cells. There was not a single case of complete normalization of the bone marrow punctate picture. Follow-up observations of patients over periods from 3 months up to 4 years demonstrated persistence of the results. It is concluded that the method under discussion is promising and deserves further study. (auth)

33085 EFFECTIVENESS OF CYSTAMINE DEPENDING UPON THE METHOD OF ADMINISTRATION AND THE X-RAY DOSAGE. Ilin, L. A.; Lukash, N. I. Med. Radiol., 11: No. 1, 70-3(Jan. 1966). (In Russian).

The radio-protective effect of cystamine, depending upon the route of its introduction prior to x-irradiation with different doses, was studied in experiments carried out on pedigreed and mongrel mice. When given per os crystamine failed to afford any protection, while its parenteral administration proved effective. (auth)

33086 INTERESTING CASE OF MEDIASTINAL TUMOR. Fujii, Kyoichi; Machuwura, Kaiichi; Imada, Likio; Fugimoto, Ukio; Tokuda, Tanezi (Hiroshima Atomic Bomb Hospital). Nagasaki Igakkai Zasshi, 38: Suppl., 104-8(Dec. 1963). (In Japanese).

A patient with a rare malignancy who was exposed to radiation from atomic bombing is described. Up to 1957, 70 mediastinal teratomas were reported in the world literature. In Japan, 20 cases were reported; the average age of the patients was 21 years and the sex predominantly male (only one case was female). The case described was that of a 29-year-old male with a history of atomic bombing exposure who entered Nagasaki on Aug. 8, 1945. His chief complaints at that time were swelling of the face and neck and shortness of breath. In 1952, physical examinations revealed signs of the superior vena cava syndrome. There was edema in both eyelids, swelling in the neck and the forechest, venous enlargement in the neck and forechest, and congestion of the throat but no palpable cervical lymph nodes. Laboratory findings showed negative results except for leukocytosis of $13{,}500/mm^3$, with normal differential counts. Under the diagnosis of the lymphosarcoma, deep-x-ray therapy was initiated, resulting in the disappearance of the symptoms. As a result of severe hematopoietic depression, radiotherapy was terminated at 6500 R for a total tissue dose of 3500 R. Serial chest x-ray films showed no improvement in the mediastinal tumor shadow and in the atelectasis of the right upper lobe. Four months later the patient died, and the pathological report from autopsy revealed malignant mediastinal teratoma with multiple metastases. (BBB)

33087 RADIATION INJURIES TO RATS UNDER INFLUENCE OF HEXAMETHYLENETETRAMINE. Peters, Karl; Peters, R. (Univ., Tuebingen, Ger.). Naturwissenschaften, 53: 275(1966). (In German).

The effects of hexamethylenetetramine on radiation injuries in rats exposed to doses of 920 and 800 R were investigated. The hexamethylenetetramine was administered in the drinking water 10 days before irradiation, 10 days after irradiation, and 10 days before and 10 days after irradiation. The administration of hexamethylenetetramine 10 days before irradiation and 10 days before and 10 days after had a more favorable affect than the administration 10 days after irradiation. However, even the postirradiation treatment increased the survival of the rats. (J.S.R.)

33088 THE RADIOPROTECTION OF SACCHAROMYCES CEREVISIAE BY CYSTAMINE AS MEASURED BY DIFFERENT CRITERIA OF CELL DAMAGE. Stuart, Bruce Owen; Stannard, J. N. (Univ. of Rochester, N. Y.). Radiat. Res., 28: 609-23(July 1966).

The protection afforded by the dithiol cystamine (2,2'-dithiobisethylamine) against radiation damage in diploid bakers' yeast was measured by using three independent criteria: membrane function as measured by leakage of intracellular potassium; ability to form colonies; and early cell death as measured by uptake of methylene blue. X irradiation of cell suspensions was performed at 1600 R/min, with total doses from 0 to 88 kR. The loss of K^+ could be represented by first-order kinetics and a specific loss constant calculated in each experiment. The usual increase in K^+ loss from the irradiated cells was markedly reduced by the presence of 10^{-2} M cystamine during exposure in oxygen at pH 6.5 or 4.0. Both the magnitude of the damage and the protection afforded by cystamine were considerably lower if irradiation took place in nitrogen. There is evidence that the dose-response curve for membrane damage is biphasic, with cystamine affecting only one phase (or site or mechanism), so that the curve becomes monophasic in its presence. By contrast, inhibition of colony formation was essentially identical whether cystamine was present or absent during irradiation, although the magnitude of the radiation effect was greater in oxygen. Only a few percent of the cells took up methylene blue at any dosage level, indicating that the potassium loss measured is not referable to nonspecific killing of the cells. It is postulated that cystamine may exert its protective effect on radioinduced changes in potassium exchange by action at or close to the cellular membrane and that the agent cannot penetrate the cell interior to protect against effects on growth. (auth)

33089 EFFECTS OF β-MERCAPTOETHYLAMINE ON GROWTH AND RADIATION SENSITIVITY OF ESCHERICHIA COLI STRAIN 15TAU-BAR. Ginsberg, David M. (Walter Reed Army Inst. of Research, Washington, D. C.). Radiat. Res., 28: 708-16(July 1966).

The addition of MEA to a logarithmically growing culture of Escherichia coli strain 15TAU-bar resulted in immediate cessation of net protein, but not DNA, synthesis. This change in growth state appears to be the sole reason for the increase in radiation resistance of the logarithmic-phase culture incubated in MEA before irradiation. Preirradiation incubation of a stationary-phase culture with MEA did not give radioprotection. Maximum protection of stationary-phase cultures was obtained by adding MEA to the culture immediately prior to beginning irradiation. Logarithmic-phase cultures were also protected against ionizing radiation killing if MEA was present in the cell suspension only during irradiation. This protective effect is additive with protection afforded by preirradiation incubation with MEA. (auth)

33090 EFFECTS OF RADIATION MEDIATING AGENTS ON THE RESPONSE OF A MURINE EPENDYMOMA TO PROTON IRRADIATION. Stratton, K.; Anderson, A.; Koehler, A. M. (Massachusetts General Hospital, Boston. Harvard Univ., Cambridge, Mass.). Radiology, 87: 68-73 (July 1966).

The radiobiological response of experimental brain tumors was examined, using two subcutaneously transplantable, rapidly growing murine ependymomas. Tumor take after in vivo irradiation and subsequent transplantation into unirradiated C3H mice was compared for 55 Mev proton and megavoltage x radiation. At the 50 per cent tumor take level, the RBE for proton versus megavoltage x rays was 1.1(8) for tumor No. 15. The protective effect of AET on this tumor was assayed by administering 350 mg/kg intraperitoneally twenty minutes before irradiation. At the 50 per cent take level the dose reduction factor was 1.1(7) for 55 Mev protons and 1.2 for x rays. IUDR was tested as a sensitizing agent to proton radiation of Tumor No. 48 by administering 150 mg/kg intraperitoneally twice daily for four days prior to irradiation. At the 50 per cent take level, the dose increase factor for IUDR was 1.7. In general, the results indicate that the effects of high-energy proton radiation on gliomas are essentially similar to those reported for x radiation of other types of transplantable tumors. (P.C.H.)

33091 HYALURONIC ACID IN ACUTE RADIATION SICKNESS. Bozduganov, At. Sb. Tr., Nauch.-Izsled. Onkol. Inst., Sofia, 8: 37-9(1962). (In Russian).

A review on the effects of ionizing radiations on hyaluronic acid and the changes of hyaluronidase is followed by personal observations of the application of hyalurine in experimental radiation sickness. Studies were made on 67 white rats divided into 5 groups. Irradiation was given in doses of 800 R in single application for 59 minutes at a dose rate of 13.6 R/min. The indexes of lethality, weight, and clinical and hematological changes were studied. It was concluded that hyalurine displays no protective properties in acute radiation sickness. Its application might contribute to increasing lethality of the irradiated animals. (P.C.H.)

33092 EFFECT OF INTERMITTENT HYPOXIA ON REGENERATION OF HEMOPOIESIS IN RATS TREATED WITH CYCLOPHOSPHAMIDE OR TOTAL-BODY IRRADIATION. Hoest, Herman (Norsk Hydro's Inst. for Cancer Research, Oslo). Scand. J. Haematol., 3: 193-204(May 15, 1966).

The effects of intermittent hypoxia on regeneration of hemopoiesis in rats treated with cyclophosphamide or whole-body irradiation are described. The rats were exposed to a gas mixture consisting of 10% oxygen and 90% nitrogen within one-half hour after treatment. Exposure to hypoxia lasted for 8½ hours daily. The irradiated and cyclophosphamide treated animals differed markedly in their response to hypoxia. Thus, in the cyclophosphamide treated animals hypoxia induced a steady increase in red cell production following the initial stop in erythropoiesis caused by the treatment. In contrast, in the irradiated rats recovery was slower and also a second failure of erythropoiesis occurred during recovery. This second failure of red cell production coincided with the second failure of the myelopoiesis in the same animals. Although whole-body irradiation and cyclophosphamide treatment caused initially about the same extent of marrow hypoplasia, the present results indicate that irradiation caused more damage to the cells than did cyclophosphamide. (auth)

33093 RADIOPROTECTIVE EFFECT OF GLYCEROL IN YEAST CELLS OF DIFFERENT PLOIDIES. Schmidt, Werner F. (Freie Univ., Berlin). Z. Naturforsch., 21b: 145-7(Feb. 1966). (In German).

The radioprotective effects of glycerol were studied on haploid, diploid, and tetraploid yeast cells (Sacch. cer.). The experimental results can be explained on the basis of a physical adsorption process as suggested by Webb (Radiation Res., 18: 607(1963)). (auth)

33094 INVESTIGATIONS ON THE MECHANISM OF THE RADIOPROTECTIVE EFFECTS OF THIOL AND DISULFIDE COMPOUNDS ON THE MODEL OF BIOLOGICAL ELEMENTARY UNITS. Hotz, G. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 21b: 148-52(Feb. 1966). (In German).

The inactivation of plaque forming ability of T1 bacteriophage by ^{60}Co-gamma and x rays was used to test the protective action of different concentrations of cysteamine and cystamine in broth-suspension in the dry state at 300 and at 80°K, respectively. Under all experimental conditions the amount of radioprotection afforded by the disulfide was comparable within a few percent to the protection afforded by the thiol. The protective mechanism by which both compounds act at room temperature or at 80°K is discussed emphasizing evidence in favor of the hypothesis of electron-hydrogen donation. Oxygen reduced the efficiency of this mechanism by competing with the thiol as well as with the disulfide for radioinduced radicals in the phage DNA. Experimental evidence is given for the conclusion that cystamine need not be reduced by enzymes or radiation to show efficient radioprotection. (auth)

33095 THE EFFECT OF X RADIATION ON THE GROWTH OF LACTOBACILLUS DELBRUCKII AND THE ROLE OF METALLIC TRACES IN THE OCCURRENCE OF BIOLOGICAL X RAY EFFECTS. Kayser, Detlev (Max-Planck-Institut fuer Zellphysiologie, Berlin). Z. Naturforsch., 21b: 167-72(Feb. 1966). (In German).

If Lactobacillus delbruckii, whose metabolism is very similar to that of cancer cells, is killed with x radiation, the destruction is caused exclusively by the H_2O_2 produced by the radiation in the suspension medium. Destruction can be completely inhibited by the addition of ethylenediaminetetraacetic acid which complexes the heavy metal traces. The chemical mechanism through which x radiation destroys the bacteria in this case is an oxidation effect of the hydrogen peroxides catalyzed by the heavy metals. (trauth)

33096 PHOTODYNAMIC INACTIVATION OF E. COLI PHAGES T4: INVESTIGATION OF THE HYBRIDIZATION REACTIVATION AND THE PROTECTIVE EFFECTS OF SPERMINE. Brendel, M.; Winkler, U. (J. W. Goethe Univ., Frankfurt am Main). Z. Vererbungsl., 98: 41-8 (1966). (In German).

The lethal effect of methylene blue (MB) plus light on extracellular phage T40 is mainly due to lesions in the DNA; the extent of this DNA-specifity is about 80% of that of the lethal effect of ultraviolet light. This has been concluded from marker rescue experiments performed with uv-as well as with photodynamically inactivated phages. The difference by a factor of 3.5 in the photodynamic sensitivity of T40 and $T40^+$ could be referred to the fact that the mutant lacks polyamines, because addition of spermine to T40 increases its resistance at least to the wildtype level. Glucose-containing and glucose-lacking T4-phages show almost the same photodynamic sensitivity so that the difference in the sensitivity of T4 and T2 probably is not due to their various degree of glucosylation. (auth)

33097 USE OF RADIOLUMINESCENCE FOR THE INVESTIGATION OF THE MECHANISM OF RADIATION SHIELDING. Pisarevskii, A. I.; Seleznev, A. F. Zh. Prikl. Spektrosk., 2: No. 2, 181-3(1965). (In Russian).

A physical model is proposed for study of the shielding effect of various protectors against biological radiation damage. The model is based on the analogy between the quenching action of certain substances in liquid scintillators and the protective action on biologically vital molecules and supermolecular structures (such as DNA), for both in quenching and in protection part of the radiation energy is diverted from the target. The liquid scintillator was PPO dissolved in dioxane, and protectors were used of the standard type (AET, MOT, MPA, and ST), all in aqueous solutions with pH = 1.7. The tests consisted of determining the influence of the introduced molecules on the luminescence spectrum of the PPO and the dependence of the scintillation efficiency on the amount of introduced protector. The results show that AET, MPA, and MOT divert part of the energy of the electronic excitation that is capable of migration. The data on the quenching action are in qualitative agreement with the radiobiological data on phages and show that the energy diversion (quenching) is an effective factor in shielding. (ATD)

33098 DERIVATIVES OF DIARYLTHIOCARBOHYDRAZIDES IN PROPHYLAXIS OF ACUTE RADIATION SICKNESS. Gorodetskii, A. A.; Dubenko, R. G.; Pel'kis, P. S.; Ryabova, E. Z. pp 179-92 of Patogenez, Eksperimental'naya Profilaktika i Terapiya Luchevykh Porazhenii. Lebedinskii, A. V. (ed.). Moscow, Izdatel'stvo Meditsina, 1964. (In Russian).

The action of new radiation protection preparations of the group of diarylthiocarbohydrazides and diarylthiocarbamide was studied. Various derivatives of 1,5-diphenylthiocarbohydrazide were synthesized and studied as radiation protection agents. It was found that these derivatives are able to form internal complexes with cations of heavy metals, that they possess reducing properties, and, depending on the pH of the medium, react in the thion or thiol form. The greatest protective activity in the irradiation of animals with lethal doses of x-rays was exhibited by the derivatives of 1,5-diphenylthiocarbohydrazide and 1,3-diphenylthiocarbamide with substitutions which give them solubility in water: disodium salt 1,5-di-(4-sulfonephenyl)-thiocarbohydrazide (preparation No. 12); disodium salt 1,5-di-(4-carboxyphenyl)-thiocarbohydrazide (preparation No. 19); 1,5-(4-amidosulfanylphenyl)-thiocarbohydrazide (preparation No. 9); and disodium salt 1,3-di-(m-oxy, n-carboxyphenyl)-thiocarbamide (preparation No. 26). The most effective preparations (Nos. 12 and 26) possess marked toxic properties. (ATD)

Radiation Hazards and Protection

See also HEALTH AND SAFETY

33099 RADIANT ENERGY RECEIVED BY PATIENTS IN DIAGNOSTIC X-RAY PRACTICE. Morgan, Russell H.; Gehret, Judith C. (Johns Hopkins Univ., Baltimore). Amer. J. Roentgenol., Radium Therapy Nucl. Med., 97: 793-810(July 1966).

A study is reported in which the radiant energy projected on more than 36,000 patients undergoing diagnostic x-ray examination at the Johns Hopkins Hospital was measured. The data appear to be quite useful in the evaluation of the levels of unnecessary exposure prevailing in diagnostic radiology, particularly when such unnecessary exposure is due to excessive field size in radiography. Such measurements may also be used effectively to estimate the annual genetic dose due to diagnostic x-ray methods. The relative ease with which such measurements may be collected permits the study of annual genetic dose on a continuing basis. (P.C.H.)

33100 DOSE TO BONE FROM ^{90}Sr: IMPLICATIONS FOR THE SETTING OF THE MAXIMUM PERMISSIBLE BODY BURDEN. Spiers, F. W. (Univ. of Leeds, Eng.). Radiat. Res., 28: 624-42(July 1966).

Consideration is given to the choice of critical tissues in bone in relation to the setting of the maximum permissible body burden (mpbb) for ^{90}Sr, and the β-particle dose rates to bone marrow and to endosteal tissues in trabecular bone are then calculated. The calculations are based on mensuration of certain bones of the skeleton and on measured distributions of marrow cavity sizes in the trabecular bone. The dose rates for a skeletal burden of the 1 μC $^{90}Sr + {}^{90}Y$ are 0.55 rad/year to bone marrow and 1.1 rad/year to endosteal tissues. Assigning a bone marrow dose of 5 rem/year would imply a value of the mpbb for ^{90}Sr of 9 μC. The dose rate to the bone marrow of a child aged 5 years is also calculated to be 4.1 rads/years for a skeletal burden of 1 μC and 0.82 mrad/year for a skeletal contamination of 1 uC of ^{90}Sr per gram of Ca. (auth)

33101 COMPLEX THERAPY OF A SUBACUTE RADIATION SICKNESS INDUCED IN GUINEA PIGS BY CHRONIC IRRADIATION. Belousova, O. I. pp 258-66 of Patogenez, Eksperimental'naya Profilaktika i Terapiya Luchevykh Porazhenii. Lebedinskii, A. V. (ed.). Moscow, Izdatel'stvo Meditsina, 1964. (In Russian).

A total of 95 guinea pigs were given an x ray dose of 10 R per day six times a week until a cumulative dose of 600 R was administered. Immediately after irradiation the animals were given 10 mg/kg of tryptophan daily, 10 mg/kg of histidine daily, a 1 μg/hg of vitamin B_{12} daily, 3 mg/kg of pyridoxine daily, 5 mg/kg of thiamine daily, 0.7 mg/kg of folic acid 3 times a week, 100 mg/kg of ascorbic acid daily, 50 μg/kg of biotin 3 times a week, and/or 60 mg/kg of citrin daily. The use of tryptophan and histidine along with the group B vitamins increased the survival of the animals by 20 to 30% as compared to the controls. On adding 5 to 50 mg/kg of orotic acid to the diet either separately or with folic acid, the survival increased by 20 to 30% as compared to the controls. The use of orotic acid along with folic acid moderated the hematopoietic disturbance due to irradiation. The use of

the amino acids, group B vitamins, ascorbic acid and citrin did not improve the survival, but had a beneficial effect on the hematopoietic system. On adding ascorbic acid and citrin to the folic acid and orotic acid treatment, the survival improved by 50% in comparison to the controls, and hematopoiesis was significantly improved. (TTT)

33102 RADIATION BARRIER APPARATUS. Harting, Glen R. (to Borg-Warner Corp.). U. S. Patent 3,246,438. Apr. 19, 1966. Filed Dec. 31, 1962.

A radiation barrier apparatus is provided for installation in new or existing homes by nonskilled homeowners and offers not only radiation protection but protection from heat and high temperatures. The barrier device is adaptable to wall or ceiling installations and provides an additional advantage of acting as a sound retardation material. The space between existing ceiling or floor joists is divided into two chambers by additional joists, and metallic sheet metal strips are placed along the longitudinal bottom margin of the sides of each joist and secured in place. Retainers consisting of sheet metal span the distance between the mounting brackets of adjacent joists. The chamber so formed between each joist is filled with some radiation barrier material such as sand. (B.L.M.)

Radiotherapy and Radiodiagnosis

Refer also to abstracts 33037, 33606, and 33762.

33103 (UCRL–16899) TOMOGRAPHIC GAMMA-RAY SCANNER WITH SIMULTANEOUS READOUT OF SEVERAL PLANES. Anger, Hal O. (Lawrence Radiation Lab., Univ. of California, Berkeley). May 31, 1966. Contract W-7405-eng-48. 20p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

By applying principles from the scintillation camera to large-crystal, focused-collimator γ-ray scanners, five or more pictures can be obtained from a single rectangular scan that show activity at different depths with maximum resolution. In each picture, activity lying on a given plane will be shown in sharp focus, while activity lying on other planes will be superimposed but blurred, as in x-ray tomography. Included is a preliminary description and theoretical study of the instrument, presented prior to its construction and use. The instrument will consist essentially of a γ-ray image detector as used in the scintillation camera (except for having a thicker scintillator and a smaller number of phototubes), and a special optical readout camera. While the γ-ray image detector scans the subject in the same manner as a conventional rectilinear scanner, the film in the optical readout camera scans in synchronism. By the use of several lenses with graded focal lengths in the optical readout camera, five or more pictures, each resolving a different plane within the subject, will be obtained from a single CRT display of the photopeak scintillations occurring in the image detector. The new instrument should be more useful for locating lesions at unknown depths than the presently available single-focal-plane scanners, and it should be very practical to construct and operate. (auth)

33104 RADIOACTIVE BISMUTH ^{206}Bi. EXPERIMENTAL STUDIES AND CLINICAL APPLICATIONS. Van Der Werff, J. Th. (St. Canisius Hospital, Nijmegen, Netherlands). Acta Radiol., Suppl. 243, 1-89(1965).

A review is presented on the pharmacologic and physical properties of bismuth, experimental studies, and therapeutic applications. Descriptions are given of some special instruments constructed for the safe handling of radioactive bismuth, and of the way in which measurements of the radiation of samples and of the whole animals were carried out. Experiments on healthy rabbits in which different compounds of ^{206}Bi were injected intravenously are also reported. It was concluded that radioactive ^{206}Bi has many useful therapeutic properties. (54 references). (P.C.H.)

33105 HYPOPHYSECTOMY WITH ^{90}Y. Hawken, Patty (Frances Payne Bolton School of Nursing, Cleveland). Amer. J. Nursing, 65: 122-5(Oct. 1965).

Techniques, clinical results, and complications of radioyttrium-induced ablation of the pituitary for malignant disease, diabetes, and acromegaly are considered. The importance of nursing care in recognizing and treating the complications of yttrium-90 therapy is emphasized. Although ytrium-90 has a half life of 64 hr, 1 to 2 months may be needed to determine the amount of destruction of the gland because of edema and necrosis in the localized area. However, some results of the procedure are noticeable early. Various surgical approaches have been used to implant yttrium-90 into the pituitary. The transnasal-transsphenoidal method is the usual method. This technique, in which a screw closes off the portal, has helped appreciably to reduce the complication of meningitis. But if the implant did not securely seal off the sella turcica, or if the pituitary diaphragm received too high a dose of radiation and disintegrated, cerebral spinal fluid will escape. This leakage can be noted by a clear nasal drip or a frequent post-nasal drip which causes the patient to swallow constantly. An open portal such as this can lead to meningitis; it needs to be noted and treated early. If the patient is bleeding, or has rhinorrhea, it is important to allow the fluid to escape by keeping his head elevated. Since diabetes insipidus is a possible complication, accurate records of intake and output are essential. Other observations that are important are those concerned with the patient's vision. If the yttrium has been placed too far laterally, damage to the oculomotor, trochlear, or abducens nerves, which regulate eye movements, may occur; if the yttrium has been placed too high, the optic nerve may be damaged. Adrenal crisis, with anorexia progressing to nausea and vomiting, weakness, lethargy, and prostration, can occur on the second or third postoperative day if the postoperative dosage of cortisone acetate is not adequate. (BBB)

33106 HUMAN LIVER AFTER RADIATION INJURY. A FORM OF VENO-OCCLUSIVE DISEASE. Reed, George B. Jr.; Cox, Alvin J. Jr. (Stanford Univ., Palo Alto, Calif.). Amer. J. Pathol., 48: 597-611(Apr. 1966).

Therapeutic irradiation of the adult human liver with doses of 3,000 to 5,900 rads was followed by intense hyperemia and hepatic cell loss, most pronounced near the lobule centers. This was associated with progressive fibrous obliteration of small branches of the hepatic veins. The process is interpreted as a variety of veno-occlusive disease in which collagen fibers appear progressively within vascular channels without pre-existing thrombosis. Possible mechanisms are discussed. In patients who survived more than 4 months there was evidence of re-establishment of an effective hepatic circulation, with return of the hepatic structure toward normal. Relatively little scarring of the liver developed, even after one year. (auth)

33107 TELECOBALT THERAPY WITH LARGE DOSES FOR CANCER OF THE BREAST: LOCAL DEVELOPMENT AND SEQUELAE. Sarrazin, D.; Lalanne, C. M. Ann. Radiol., 4: 377-89(1966). (In French).

From 1962, to July 1964, a total of 87 cases of advanced and developing mammary cancers were given, as the initial treatment, a loco-regional irradiation with telecobalt, using large doses (7,000 to 10,000 R). In 58 of these cases an effect of the large doses on the loco-regional lesions could be observed; in 64% of the cases they were brought under control. It was found that for this result to be obtained a dose of 7,000 R was a threshold dose and that the best results were obtained with 8,000 R. Unfortunately, at these doses the largest number of post-therapeutic sequelae were encountered. Sixty-eight patients could be followed up and examined for such complications. It was found that the incidence was fairly low (approximately 10%) and that the functional symptomatology was very mild in spite of the large doses administered. It would therefore appear that the method is certainly justified. (auth)

33108 THE TREATMENT OF CARCINOMA OF THE UTERINE CERVIX USING A LINEAR VAGINAL SOURCE AND 4-Mev X RAYS. Campbell, Elisabeth M.; Douglas, Mary (Western General Hospital, Edinburgh). Brit. J. Radiol., 39: 537-46(July 1966).

A method is described for the treatment of carcinoma of the cervix using intrauterine radium and a linear vaginal source combined with 4 Mev x-ray therapy. The treatment is simple and flexible, and the initial results obtained are encouraging. With the experience so gained and further modification using radioactive cesium sources it is hoped to reduce the morbidity. Using radium or radioactive cesium the method is suitable for use in underdeveloped countries where the resources and technical help of a full-scale radiotherapy department are not available. (auth)

33109 RADIATION BEAM ALIGNMENT DEVICE FOR USE WITH A HYPERBARIC OXYGEN CHAMBER. Johnson, R. J. R.; Legal, J. (Winnipeg General Hospital, Manitoba, Can.). Brit. J. Radiol., 39: 558(July 1966).

A mechanico-optical device was designed to facilitate field alignment when using a hyperbaric chamber. The light beams from this device normally strike the Perspex at right angles, thus giving minimal deviation. Three sets of cross-hairs are used for alignment. (P.C.H.)

33110 POSTIRRADIATION FUNCTIONAL MANIFESTATIONS ON THE STOMACH CAUSED BY PHENMETRAZINE AND DEXPHENMETRAZINE. Brueckner, L.; Pauk, J. Cesk. Gastroenterol. Vyziva, 18: 118-24(Mar. 1964). (In Czech).

Physiological effects of phenmetrazine and dexphenmetrazine were studied in stomachs of patients given various doses of ionizing radiation to localize malignant tumors and in non-irradiated subjects. X-ray examination following administration revealed enhanced peristalsis and more rapid evacuation of the stomach into the small intestine in irradiated patients. It is suggested that the effect was due to stimulation of cholinergic structures of the nervous system. (H.G.D.)

33111 EWING'S SARCOMA: STUDY OF TREATMENT METHODS. Jenkin, R. D. T. (Princess Margaret Hospital, Toronto). Clin. Radiol., 17: 97-106(Apr. 1966).

The case histories of 45 patients with Ewing's sarcoma, and the results of treatment are reviewed. The primary tumors were uniformly radiosensitive and radiation was the treatment of choice, giving a tumor dose of 4500–5000 rads in 3 to 5 weeks. A few tumors were radiocurable. Metastases responded best to radiotherapy, but, in addition, Procytox (cyclophosphamide) appeared to delay the progress of the disease at this stage. The drug is now used in maintenance dose levels, from the appearance of the first metastasis. Ewing's sarcoma is considered to be a radiosensitive, potentially radiocurable tumor, where the main cause of therapeutic failure is early metastatic spread. A trial is therefore now being undertaken of whole-body radiation, in a single dose of 300 rads, in addition to local irradiation of the primary tumor. (auth)

33112 TREATMENT OF ADVANCED RETINOBLASTOMA BY MEANS OF EXTERNAL IRRADIATION COMBINED WITH CHEMOTHERAPY. Skeggs, David B. L.; Williams, Ivor G. (St. Bartholomew's Hospital, London). Clin. Radiol., 17: 169-72(Apr. 1966).

Descriptions are given of 40 patients with advanced retinoblastoma who have been treated with external cobalt teletherapy combined with cyclophosphamide. Consideration of the radiosensitivity of the various structures in the eye, and a review of the literature suggested that the most suitable radiation dose was 3,500 rads in 28 days; the dose of cyclophosphamide varied between 2.0 and 3.0 mg/kg, according to the age of the child. Thirty of the 40 children are fully documented and have been followed for a minimum period of 8 months: of these, 70% retain some useful vision without evidence of tumor activity. Complications have been uncommon. (auth)

33113 RADIATION BIOLOGY AS APPLIED TO RADIOTHERAPY. Fowler, J. F. (Univ. of London). pp 303-64 of Current Topics in Radiation Research. Vol. II. Ebert, Michael; Howard, Alma (eds.). Amsterdam, North-Holland Publishing Company, 1966.

The importance of radiobiology in radiotherapy is reviewed. Topics covered include: questions in clinical radiotherapy; cellular theories of radiosensitivity; problem of anoxic cells in tumors; and radiation fractionation. (119 references). (P.C.H.)

33114 RADIATION INJURY OF TEETH AND JAWS. Sonnabend, Eberhard (Univ., Goettingen, Ger.). Fortschr. Kiefer- Gesichtschir., 8: 37-43(1962). (In German).

This dental clinic survey of 522 patients who received oral irradiation, mainly for hemangioma, carcinoma, cancroid, and parotid gland mixed tumors, shows that the use of increasing doses in the irradiation of tumors in the mouth has led to increasing damage to the teeth and jaw. Follow-up examination of 159 patients treated for various tumors of the face during the last 10 to 15 years, among the 522 patients, showed abnormal findings in 33 cases (21%). Injury to teeth, gums, or osteoradionecrosis accounted for 14%. A definite relation between these changes and the radiation dose was demonstrated. A chief contributory cause of osteoradionecrosis is dental infection or infection of paradental tissues and the alveolus following dental extraction. It is essential to avoid infection in a radiation-exposed jaw and all teeth lying within the area to be irradiated must be extracted 8 to 10 days before any intensive treatment with ionizing radiation. Pathologic changes occurring in irradiated teeth are described and illustrated. (BBB)

33115 BILATERAL HEMOPHILIC PSEUDOTUMORS OF THE CALCANEUS AND CUBOID TREATED BY IRRADIATION. Chen, Yung Fu (Taiwan Provincial Taipei Hospital). J. Bone Joint Surg., 47-A: 517-21(Apr. 1965).

A case is presented in which bilateral pseudotumors of the calcaneus and cuboid in an 11-yr-old boy with apparent classic hemophilia responded promptly to deep x-ray therapy with relief of pain and subsequent disappearance of the tumors without recurrence for two years and eight months after treatment. Although previous reports on the effects of radiotherapy for pseudotumors have been conflicting, the results in this case were dramatic. Before irradiation, attempts were made to remove the tumors surgically. At operation the tumor was found to be a multilocular cystic mass filled with blood. Aspiration reduced the size of the mass but it promptly filled with blood again. Histological sections of the wall revealed normal bone tissue with accumulation of erythrocytes over the medullary surface. There was no untoward hemorrhage from the wound during or after operation, but postoperatively the mass increased in size and became so painful that analgesic drugs gave little relief. The patient's worsening situation suggested that bilateral amputation might be necessary, but instead it was decided to try deep x-ray therapy. The doses were 1576 R (tissue dose, mid-plane) in 16 days to the right foot and 1672 R (tissue dose) in 10 days to the left foot (factors: 250 kv, 15 ma, target-to-skin distance 50 cm, and a filter of 2.2 mm copper). Pain started to subside three days after x-ray therapy was begun and had completely ceased by the tenth day. Gradually, all the pseudotumors became smaller, and the protuberances had disappeared completely four weeks after completion of x-ray therapy. (BBB)

33116 PANEL DISCUSSION: PLACENTA PREVIA. USE OF RADIOGRAPHIC TECHNIQUES. Behlke, Frank M. J. Iowa State Med. Soc., 55: 626-8(Nov. 1965).

The development of placenta localization techniques using ionizing radiation in various forms is traced, with a discussion of the hazards of each to the fetus and maternal gonads. In 1930, it was found that the injection of a strontium iodine solution through the abdominal wall into the uterine cavity increased the radiographic density of the liquor amnii, revealing the placenta as a concentric thickening of a lesser density on the uterine wall. Reports of fetal death following the use of strontium led to a search for less toxic agent. Intravenous placentography using thorium dioxide was the second radiographic method used to differentiate the placenta from the surrounding tissues. However, this substance fell into disrepute because of its radioactivity. Tomography, laminography, or planography

never gained widespread use as a method of placental localization. The major objection to the tomographic method is that the patient and the fetus undergo an undue amount of irradiation. Radioactive isotopes were first used for this purpose in England in 1952, by utilizing an intravenous injection of radiosodium to achieve a high degree of accuracy in localizing the placenta. Since that time, many other radioisotopes have been utilized with increasing accuracy and with minimal irradiation of the fetus and mother. Thus, multiple radiographic techniques are available as aids in placental localization. All have their advantages and disadvantages, and none are ideal. Recent reports on newer radioisotopes and thermography indicate that promising improvements in radiologic methods are forthcoming. (TCO)

33117 CANCER OF THE CERVIX COMPLICATING PREGNANCY. THE PROBLEMS OF DIAGNOSIS AND TREATMENT. **Jones, Gerald I.; Hutcherson, W. Powell; Schwartz, Harold A. (Baroness Erlanger Hospital, Chattanooga, Tenn.). J. Tenn. Med. Ass., 58: 109-13 (Apr. 1965).**

Problems encountered in radiotherapy of 39 pregnant patients with cervical carcinoma are described, with emphasis on fetus salvage when early fetal irradiation can be avoided. Irradiation therapy is generally used as follows: For the first and second trimester, external irradiation, either 250- or 400-kv x ray or γ rays from ^{60}Co to deliver 2000 R. Abortion usually occurs following therapy. This is followed by two insertions of radium, 7 to 10 days later. This gives a tumor dose of 7500 R to Point A and 3500 to 4000 R to the pelvic wall. It is believed that fetal tissues are less sensitive to irradiation in the second trimester and that abortion is less likely to occur as a result of external irradiation. Therefore, transabdominal hysterotomy may be done initially. In the third trimester the treatment is generally classical cesarean section, performed as soon as the child reaches viability, followed by irradiation therapy. Early diagnosis and early treatment are the factors which influence the prognosis of carcinoma of the cervix complicating pregnancy. There is no evidence that pregnancy per se affects the cure rate. However, it is generally accepted that delivery through a cervix with invasive cancer may cause wide dissemination of the disease as well as hemorrhage. (TCO)

33118 PREOPERATIVE IRRADIATION IN PATIENTS UNDERGOING PNEUMONECTOMY FOR CARCINOMA OF THE LUNG: INCIDENCE OF POSTOPERATIVE CARDIAC COMPLICATIONS. **Mark, James B. D. (Stanford Univ., Calif.); Call, Edward P.; von Essen, Carl F. J. Thorac. Cardiov. Surg., 51: 30-5(Jan. 1966).**

The possible effects of ionizing radiation on the heart were studied in 60 patients with lung cancer, one-third of whom were subjected to preoperative irradiation. Doses of 6000 R were given over a 6-week period with a 2-Mev unit. A survey of postoperative cardiac complications showed that the incidence of arrhythmias and tachycardias was higher in the irradiated than in the nonirradiated group. The irradiated patients had a less smooth course in the posoperative period than the other group. There were no demonstrable differences in intraoperative technical problems or in the incidence of postoperative wound complications. There were four in-hospital postoperative deaths in the 20 irradiated cases and only one in the nonirradiated group. Even though a comparable percentage of the two groups are now dead, the average length of life in patients who died was twice as long in the nonirradiated group (14 vs 7 months). The major advantage of preoperative irradiation in patients with lung cancer seems at present to be the conversion of unresectable lesions into resectable ones. This may be a significant therapeutic benefit, but it results in a high operative mortality and postoperative cardiac complication rate. These disadvantages can be justified only by increases in survival and greater palliation, neither of which has been demonstrated in these patients. (TCO)

33119 AUTOIMMUNITY AFTER IRRADIATION. **Lancet, 1: 476-7(Feb. 26, 1966).**

A brief review is presented of the recently discovered possibility that autoimmune disorders may develop subsequent to radiotherapy. At least 2 out of every 10 patients with malignant lymphoproliferative or myeloproliferative disease (such as chronic lymphatic leukemia or myelosclerosis) develop one or several autoimmune complications, such as hemolytic anemia, thrombocytopenia, vasculitis, or rheumatoid lesions. Of 100 cases of lymphosarcoma and chronic lymphatic leukemia, 18 patients had autoimmune manifestations. Of the 18 patients, 5 had been treated with irradiation or radiomimetic drugs (mostly for lymph node and splenic enlargement). The autoimmune response developed suddenly within a few weeks of starting treatment, and in at least 2 it was the immediate cause of death. In no case did such complications follow steroid therapy. The mechanism of immunoenhancement of x rays and radiomimetic drugs is uncertain. Cellular breakdown products (e.g., nucleic acids) may enhance antibody synthesis; or an overshoot of cellular proliferation may follow the restoration of normal lymphopoiesis after x-ray damage. In patients with lymphoproliferative disease, one of two processes may be responsible: x-ray therapy could unmask or aggravate a preexisting subliminal autoimmune state; or it may destroy the immunological tolerance of leukemic (or nonmalignant but abnormal) lymphocytes to the patient's antigens. (TCO)

33120 PROBLEMS OF COMBINED CHEMO- AND RADIUM THERAPY. **Cheyallier, A. (Inst. of Medical Radiology, Academy of Sciences, USSR). Med. Radiol., 10: 24-32(Aug. 1965). (In Russian).**

Rats that were maintained under strictly controlled laboratory conditions of diet and environment were given a cyclophosphamide (CPA) dose from 3.6 to 15 mg per 1 kg of body weight, and an x-ray dose of 80 R in various combinations. The decrease in the number of cells per 1 mg of bone marrow was taken as a criterion of the biological insult. It was found that the sum of the effects was additive, and that there was no potentiation with a combined treatment. Each agent apparently acted independently of the other. The recovery in cell count was slower on giving the rat two single CPA doses of 15 mg per 1 kg of body weight at three day intervals than it was on giving the rat two 80 R x-ray doses within a three day interval. The cummulative effect of the chemical agent (CPA) was greater when the chemical agent was administered after the x-ray treatment. Administration of the chemical agent and of the x-ray treatment on the same day gave the greatest effect. (TTT)

33121 CLINICAL PICTURE AND TREATMENT OF RADIATION-INDUCED CYSTITIS SECONDARY TO RADIOTHERAPY OF THE UTERINE CERVIX. **Mikhnovskaya, I. G.; Tsomaya, G. A. Med. Radiol., 11: No. 1: 23-7 (Jan. 1966). (In Russian).**

From among 370 women subjected to x ray and radium therapy of cancer of the uterine cervix for the last 12 years, 29 were found to have radiation-induced cystitis and 3 others had vesicovaginal fistulas. Patients with radiation-induced cystitis developed it as a late complication which developed in 3 months and often even after a lapse of 1 to 4 years after termination of the radiotherapy. All those patients were given urological examinations. Concurrent infections habitually aggravated the evolution of radiation-induced cystitis. Biopsy and cytological analysis of the urine were made to establish a differential diagnosis between radiation-induced cystitis and proliferation of the tumor into the urinary bladder. The following treatment was given to patients with radiation-induced cystitis, depending upon the stage of the affection: instillation into the bladder of vitaminized cod liver oil alternately with novocaine; prevesical and presacral blocks; hydrocortisone hormone therapy; and administration of prednisolone and adenocorticotropic hormone. The latter were introduced endovesically with the aid of a needle introduced into the uninary bladder

mucosa at the affected site; intramuscularly; or enterally. The treatment proved quite successful in 18 out of 29 patients. (auth)

33122 ESTIMATION OF RELATIVE DEPTH DOSES FOR X-RAY AND GAMMA RADIATION. Krongaus, A. N.; Shagimardanov, N. Sh. (Research Inst. of Roentgen-Radiology, Ministry of Public Health, USSR). Med. Radiol., 11: No. 1, 82-7(Jan. 1966). (In Russian).

Formulas are presented for use in the estimation of relative percentage depth doses, depending upon the attenuation of the half-value layer, expressed in mm of copper, the distance between the source and skin and the area of the irradiated field. (auth)

33123 RADIOPHARMACEUTICALS: THEIR USE IN NUCLEAR MEDICINE. Wagner, Henry N. Jr. (Johns Hopkins Univ., Baltimore). Nucleonics, 24: No. 7, 62-6; 84-5(July 1966).

The discussion of radiopharmaceuticals includes a brief history of their development, the properties and uses of these drugs, and the characteristics of the ideal radiopharmaceutical. Also production techniques, quality control, iodination procedures, and new developments in this field are considered. (J.F.P.)

33124 COBALT SPHERE APPLICATOR. Ravasz, Laszlo (Foevarosi Uzsoki Utcai Korhaz, Budapest). Orv. Hetilap, 105: 645-6(Apr. 5, 1964). (In Hungarian).

A new applicator is described which facilitates the introduction of a ^{60}Co source into the cervix and intrauterine cavity for the treatment of tumors. The applicator tube has an ID of 7 mm and can accommodate a string of 3 or 4 ^{60}Co beads. The bent tip aids in its introduction into the uterus. The applicator is filled from the front and the ^{60}Co spheres are pushed into the cavity by a plunger which has a rounded tip. A second, slightly different applicator is used to irradiate the cervix. This applicator takes the place of the Hager tube and has two different plungers; one fitting flush with the tube which is used to push the spheres into the cervix, the other slightly longer and rounded which is used to place the spheres at a certain distance away from the tube. Diagrams are provided to illustrate the applicator and the various plungers. This applicator has been used at this hospital since 1959 with satisfactory results. A total of 81 patients was treated in 210 instances, and the ^{60}Co spheres were successfully applied with this applicator in each instance. (BBB)

33125 METHOD OF LONGITUDINAL IRRADIATION IN ESOPHAGEAL CARCINOMA BY MEANS OF THE 25-Mev BETRATRON. Lagunova, I. G.; Cybulskij, B. A.; Kornev, I. I. Radiobiol.-Radiotherap., 7: 265-74(1966). (In German).

A method for irradiation of esophageal carcinoma by means of the 25 Mev betatron is described. Radiation is not vertically directed to the longitudinal axis of the organ as in the known methods of irradiation but from one or two opposite fields along the affected part of the organ. This yields the most favorable distribution of the radiation absorbed in the tumor and the regional lymph-nodes. It greatly succeeds in avoiding an irradiation of the vital parts surrounding the esophagus. 27 patients were treated according to the method described. The immediate results are very satisfactory. (auth)

33126 DIRECT OR INDIRECT DETERMINATION OF THE TUMOR DOSE IN IRRADIATION OF CENTRAL BRONCHIAL CARCINOMAS. Zschache, H. (Medizinische Akademie, Dresden). Radiobiol.-Radiotherap., 7: 351-7 (1966). (In German).

In 15 patients with tumors in the lungs, tumor doses were measured directly, endobronchially by means of the Bomke-dosimeter, and the results were compared with the values calculated from Grebe-Wiebe tables. The directly measured values were about 25% above the calculated ones. As in the daily routine x-ray therapy the irradiation plan is based on the calculated depth-dose values where the percentage error related to these depth-dose values calculated in tabular form is only decisive and amounts to nearly 40%. (auth)

33127 CHANGES OF DEPTH DOSE AND RADIATION INTENSITY WITH THE VARIATION OF FOCUS-SKIN DISTANCE (FSD). Chvojka, Z.; Ilja, D. (Charles Univ., Hradec Kralove, Czech.). Radiobiol.-Radiotherap., 7: 359-64(1966). (In German).

New irradiation parameters were obtained by using the lawfulness of the spreading of radiation and its absorption. The formulas given are universal and may be used for conventional x-ray therapy as well as for high-energy quantum radiation. From the results it may be concluded that the chosen variation of focus-skin distance, which leads to a significant increase of dose rate and thus to an increase of the possible irradiations, simultaneously does not decisively decrease the percentage depth dose. (P.C.H.)

33128 PROPERTIES OF MULTICHANNEL COLLIMATORS FOR USE IN SCINTIGRAPHY. Husak, V.; Wiedermann, M.; Kleinbauer, K. (Universitaetskrankenhauses, Olomouc, Czech.). Radiobiol.-Radiotherap., 7: 373-82(1966). (In German).

The fundamental principles of the properties of focussing multichannel collimators for use in scintigraphy are summarized and illustrated. Two multichannel collimators of different types were compared with cylindrical single-channel collimators as to their resolving power, sensitivity, and the produced contrast. With the same sensitivity, multichannel collimators have a better resolving power than single-channel collimators. They give a higher contrast in scintigraphic representation and their resolving power is independent of distance. The influence of gamma energy on resolving power and on the extent of the experimental radiation field in the multichannel collimator was also evaluated. Regarding their advantages multichannel collimators are an indispensable presupposition for obtaining clear scintigrams in clinical practice. (auth)

33129 PHYSICAL PROBLEMS OF SCINTIGRAPHY WITH ^{197}Hg. Husak, V.; Kuba, J.; Kleinbauer, K. (Universitaetskrankenhauses, Olomouc, Czech.). Radiobiol.-Radiotherap., 7: 383-91(1966). (In German).

The radioactive isotopes of mercury, ^{197}Hg and ^{203}Hg, were compared regarding their applicability in scintigraphy. For this purpose a series of measurements with point radiation sources as well as with phantoms was performed. The results showed that ^{197}Hg in scintigraphy provides a poorer contrast in representing areas embedded deeper in the tissue than ^{203}Hg. This is due to the higher absorption of the low-energy gamma radiation of ^{197}Hg and partly to the capture of scattered radiation which cannot be eliminated completely even by proper adjustment of the channel. The greatest advantage of ^{197}Hg for its use in scintigraphy is a considerably lower radiation exposure of the patient. The possible use of thin scintillation crystals is also advantageous. The low-energy gamma radiation of ^{197}Hg permits the construction of highly sensitive multichannel collimators. (auth)

33130 NEW INTENSIFYING SCREENS AND THE POSSIBILITIES OF REDUCING THE IRRADIATION DOSE. Lagunova, I. G.; Gurvic, A. M. (Staatliche Wissenschaftlichen Forschungsinstitut fuer Roentgenradiologie, Moscow). Radiol. Diagn., 7: 245-52(1966). (In German).

The possibilities of reducing the irradiation dose in radiography are discussed. New intensifying screens, especially those on sulfide basis with high degree of luminescence, are described. The use of a zinc cadmium sulfide screen together with specially sensitized film leads to a 3.5–5 fold reduction in irradiation dose. The screen sets for simultaneous tomography made of zinc sulfide are four times more effective than the commonly used calcium wolframate sets. The correct choice of the type of intensifying screen is of great significance in every investigation. The new lead baryte screens with improved intensifying power are suitable for cases in which the quality of the picture is determined, foremost, by the contrast. For the depiction of fine structure of bones and lungs the calcium wolframate screens are better. (auth)

33131 TREATMENT DESIGN FOR PITUITARY SUPPRESSION UTILIZING 6-Mev PHOTONS. Benbow, Robert M.; von Essen, Carl F.; Rowe, James W.; Stedeford, J. Brian (Yale Univ., New Haven). Radiology, 87: 64-7(July 1966).

Determinations of the dosimetric variables for a three-beam orientation on a 6 Mev linear accelerator include millimetric single-field distributions, 360° beam rotational contours, and partial arc rotational analyses. Rapidly decreasing dose gradients outside the target volume, minimal eccentricity of the beam and couch rotations, and reproducible immobilization and localization of the patient enable consideration of pituitary ablation with 6 Mev photons. This appears possible in spite of the anatomical proximity of the pituitary to the optic chiasm, the cranial nerves, and the hypothalamus. Maximal doses ranging from 20,000 to 25,000 rads to the pituitary may be considered while less than 4,000 to 5,000 rads are delivered to the perisellar structures. This study suggests that the economical and increasingly available 6-Mev linear accelerator may be useful in external radiological pituitary ablation. (auth)

33132 PROTECTIVE HOUSING FOR A DIAGNOSTIC X-RAY TUBE. Trout, E. Dale (Oregon State Univ., Corvallis). Radiology, 87: 75-81(July 1966).

Protection recommendations for the diagnostic x-ray tube with its housing for the past 60 years are discussed and evaluated. Also associated with the housing have been the matters of filtration and collimation. Presently, the complex x-ray source system consists of the vacuum envelope with its associated electrodes, a housing, filtration component, and a collimator. The entire system is subject to the requirement that the leakage radiation must not exceed 100 mR at 1 m in any 1 hr at any rating of the tube. (P.C.H.)

33133 PATIENT X-RAY EXPOSURE DURING FLUOROSCOPIC EXAMINATIONS WITH AN ANALYSIS OF CONTRIBUTING PARAMETERS. Sprawls, Perry Jr.; Miller, W. B. Jr.; Weens, H. S.; Cosper, J. H. (Emory Univ. School of Medicine, Atlanta). Radiology 87: 99-101(July 1966).

Patient x-ray exposure during fluoroscopic examinations were determined by recording the exposure area for each one-second time interval on tape and using a digital computer to determine the surface exposure integral in R-cm^2 (SEI) for each examination studied. It was determined that variations in SEI can be attributed to variations in the x-ray machine output rate, the average exposure area, and the total exposure time. By applying a multiple regression analysis to the data it is possible to show to what extent these three factors contribute to the variations observed in SEI. (P.C.H.)

33134 INVESTIGATION OF THOROTRAST DISORDERS: A CASE OF LIVER CIRRHOSIS 21 YEARS AFTER INJECTION. Yakazu, Yoshinobu; Okamoto, Agira; Mosi, Takesaboron; Tanaka, Tosihiko (Yokohama City Univ., Japan). Rinsho Naika Shonika, 18: 313-33(1963). (In Japanese).

A case of liver cirrhosis complicated by fatal rupture of esophageal varices is described. It occurred 21 years after injection of Thorotrast. Previous Thorotrast administration was suspected from an opaque shadow in x-ray films, and proven by biopsy and spectral analysis, leading to the definite diagnosis. As compared with three other cases of malignant tumor probably caused by Thorotrast, the small dose given in this case is of interest (10 ml vs 50 to 70 ml in the 3 other cases). Review of 127 cases in the literature reveals Thorotrast tumors are most prevalent at 40 to 60 yr of age (present case: 40 yr), with a long latent period. Males are more often affected than females (61 vs 33). In Japan, 37% of cases (12 out of 32) have a history of war injuries. In 75 out of 79 cases malignancy was present, and in 26 out of 27 cases there was hepatic fibrosis. The main damage from Thorotrast may be considered as fibrosis, partly due to foreign body reaction but chiefly due to radioactivity. Sites of malignancy are related to the injection sites but liver tumors are usually due to intravenous angiography and hepatolienography. Hemangioendothelioma of the liver accounts for 30.8% (12 cases) of hepatic malignancies (39 cases). Thorotrast-induced hepatic malignancy is frequently seen as cholangioma. Hepatolienography requires administration of a large dose (50 to 75 ml) and the latent period for tumorigenesis is short. Angiography requires injection of a smaller dose (10 to 30 ml), with a longer latent period. The latent period is 11 to 25 yr with an average of 16 yr. In view of the few cases reported in Japan, a large-scale follow-up study of Thorotrast-treated persons, as well as better case detection, is recommended. (BBB)

33135 EXISTENCE OF A CAUSAL RELATIONSHIP BETWEEN RADIATION THERAPY AND HERPES ZOSTER. Gremmel, Helmut; Schulte-Brinkmann, Wolfgang (Univ., Dusseldorf). Strahlentherapie, 130: 57-72(May 1966). (In German).

Twenty-four cases of herpes zoster (0.36%) were observed among 6,655 cancer patients treated during the years 1958 to 1964. With one exception, treatment with ionizing radiation preceeded the eruption of the herpes zoster. All of the patients were treated for malignant ailments (mostly spreading carcinomas and malignant reticuloses). After case analysis, a positive causal relationship between radiation therapy and zoster activation could not be found. Zoster activation could be explained by the following factors, appearing either in a single or combined form; advanced primary ailment with decrease in general resistance, localization of the tumor in regard to the spine in the area of the involved spinal ganglias, massive drug administration resulting in decreased resistence (corticosteroids, cytostatic substances). Furthermore, the zoster incidence rate in irradiated patients was not higher when compared to the non-irradiated patients with malignomas. (auth)

33136 STUDIES OF THE RESORPTION BEHAVIOR OF $Na^{131}I$-LABELED KNEE JOINT DISCHARGE. Wuerdinger, Herbert (Univ., Marburg, Ger.). Strahlentherapie, 130: 107-15(May 1966). (In German).

An intraarticular injection of ^{131}Na into the knee joint was done in 58 patients; the type of absorption and its pathway were studied. The patient material consisted of the following cases: 26 joints with bloody effusion, 19 joints with serous effusion, 7 joints of patients with severe disturbances in blood circulation, 1 normal joint, 1 joint after synovialectomy, 1 fungus genu, 1 arthrosis deformans ulcerosa, 1 synovitis rheumatica, and 1 joint with tuberculous effusion. Continuous direct monitoring was done over the knee, the heart, and the bladder with 3 gamma-detectors. It was found, that the course and shape of the absorption curves depended to a great extent on sufficiency or insufficiency of the capillary blood supply of the synovium rather than on the characteristics and pathogenesis of the effusions. (auth)

33137 PREOPERATIVE IRRADIATION AND BRONCHOPULMONARY SLEEVE RESECTION FOR LUNG CANCER. Jensik, Robert J. (Univ. of Illinois, Chicago). Surg. Clin. N. Amer., 46: 145-59(Feb. 1966).

Use of irradiation in 25 patients to improve the results of surgical removal of segments of bronchi affected by cancer is discussed. Both a betatron unit and ^{60}Co were used, the dose (~4500 R) and field of irradiation being similar. Following a four-week irradiation, the period of delay before operation was about four to six weeks, Prior radiation did not appreciably add to the technical difficulty of the dissection. The tissue changes encountered were related to the degree of inflammation present before radiotherapy was given; and if extensive inflammatory reaction were observed in the initial x-ray films, the technical difficulties would be present even though no radiotherapy was given. Three patients alive from five months to 18 months have recurrent metastatic carcinoma but 13 patients of the 25 are living without recurrent cancer for periods from several months to three years. It is concluded that the combination of irradiation and pulmonary sleeve resection is a justifiable therapeutic pro-

gram, creating no increase in surgical complications or mortality and providing good survival data. Initially, a problem of major concern was the healing of the irradiated, anastomosed bronchi. Actual separation occurred in only two patients. Narrowing of the anastomotic site due to excessive granulation tissue was a problem in four patients. The fact that utilizing supervoltage therapy preoperatively allowed a sleeve type procedure is over 20% of the first 100 patients treated suggests the importance of the irradiation in converting patients to sleeve resection candidates. However, there is a tendency for the development of a slowly increasing lung fibrosis in these patients that becomes more apparent with longer survival. The chest x-ray in the patients surviving two to three years show this gradual loss of lung volume in the tissues salvaged by the anastomosis. In comparison, patients having this procedure without irradiation still demonstrate a well-expanded lobe or lobes after two or three years. Lung function studies also showed a progressive impairment in irradiated but not in nonirradiated cases. (TCO)

33138 DOSIMETRY AT THE BROOKHAVEN MEDICAL RESEARCH REACTOR IN REGARD TO NEUTRON-CAPTURE THERAPY. Fairchild, R. G.; Archambeau, J. O.; Tonna, E. A.; Seibold, Clara T. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 73-4 (June 1966).

33139 COMPUTER PREDICTION OF NEUTRON-CAPTURE THERAPY RADIATION DOSE FOR THE MITR MEDICAL THERAPY FACILITY BEAM. Olson, Arne P. (Massachusetts General Hospital, Cambridge). Trans. Amer. Nucl. Soc., 9: 74-5 (June 1966).

33140 SELECTIVE VISUALIZATION OF THE PANCREAS BY SUBTRACTIVE DOUBLE-RADIOISOTOPE SCANNING TECHNIQUE. Ben-Porath, M.; Clayton, G.; Kaplan, E. (Veterans Administration Hospital, Hines, Ill.). Trans. Amer. Nucl. Soc., 9: 76-8 (June 1966).

33141 TUMOR THERAPY APPLICATIONS OF ACCELERATOR-PRODUCED NEUTRONS. Frigerio, Norman A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 79-80 (June 1966).

33142 SCINTILLATION SCANNER. Stickney, Joseph B.; Lemmermann, Clarence E.; Herring, Carl E.; Carlson, Roland W. (to Picker X-Ray Corp.). U. S. Patent Re. 26,014. May 3, 1966. Filed Apr. 22, 1965.

A portable scintillation scanner has the probe supported by a boom to be moved about manually until the probe is positioned in the desired location; then the boom is coupled to an automatic drive means to move the probe through a predetermined geographic pattern for a tracer study. The probe is supported cantilever fashion to give flexibility in conducting the study without the problems of suspending heavy, bulky, unsightly mechanisms over the patient. The scan of the patient can be conducted by moving the probe at a selected speed across a series of parallel paths that are at selected spaced intervals. A light source and a stylus are carried by the boom, and they simultaneously move with it to produce both graphic and photographic reproductions of the activity measured by the probe during the scan. (B.L.M.)

CHEMISTRY

General

Refer also to abstract 33649.

33143 (COO–733–13) THE BEHAVIOR OF ELEMENTS AT VERY LOW CONCENTRATIONS AND THE KINETICS OF ISOTOPIC EXCHANGE REACTIONS. SOLVENT EFFECTS. Progress Report No. 7. Kahn, Milton (New Mexico Univ., Albuquerque). [1965]. Contract AT (11-1)-733. 49p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Results of investigations are presented concerning inoculation of nonaqueous solutions of molecular I_2 with ^{131}I by isotopic exchange with ^{131}I absorbed on Pt. Results of studies concerning exchange of iodine atoms between molecular iodine and methyl iodide in nitrobenzene are also included. (J.R.D.)

33144 (UJV–1513) METHODS OF DETERMINATION OF STABILITY CONSTANTS OF COMPLEX COMPOUNDS. Budesinsky, B. (Ustav Jaderneho Vyzkumu, Ceskoslovenska Akademie Ved, Rez). Apr. 1966. 49p. Dep. mn.

Methods of investigating complexing constants are presented according to the composition of individual complexing systems, and not according to their physico-chemical characteristics. The corresponding physico-chemical characteristics of the various methods are referenced tabularly to their applications. A bibliography on methods of determining stability constants is included. (J.R.D.)

33145 STUDY OF CHEMICAL-FLOW REACTORS WITH RADIOACTIVE TRACERS. Mullen, Robert T. (Merck Sharp and Dohme Research Labs., Rahway, N. J.). Trans. Amer. Nucl. Soc., 9: 100-1 (June 1966).

Analytical Procedures

See also Separation Processes and Procedures

33146 (BNWL-SA–592) AUTORADIOGRAPHY AS A METHOD FOR DIFFERENTIATING PuO_2 FROM UO_2 IN IRRADIATED MECHANICALLY MIXED OXIDE FUELS. Gruber, W. J.; Hascall, J. L.; Blakeley, J. O.; DesChane, D. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 11, 1966. Contract AT(45-1)-1830. 10p. (CONF-660518–2). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From AEC Annual Metallography Meeting, Denver.

Autoradiographs made with cellulose nitrate were used to locate particles of PuO_2 in a matrix of UO_2, and determine migration and diffusion of PuO_2 in irradiated mechanically mixed oxide fuels. Procedures for making and photographing autoradiographs are described. (auth)

33147 (CEA-R–2841) CONTRIBUTION A LA DOSIMETRIE DU TRITIUM EN PRESENCE DE GAZ INACTIFS OU ACTIFS. (Contribution to the Dosimetry of Tritium in the Presence of Inactive or Active Gases). Soudain, Georges (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 16, 1965. 60p. Dep. mn.

Thesis. Submitted to Toulouse Univ. (France). Faculte des Sciences.

An apparatus for measuring selectively the contamination of air by tritium, when it is alone or when it is associated with other gaseous contaminants, was developed. The differential apparatus using two ionization chambers makes it possible to eliminate a parasitic field. In a few particular cases, the presence of the radioactive gas was studied. The use of these chambers made of stainless steel solved the problems connected with wall adsorption. The method can be applied without restriction and very easily to determining the dosages from traces tritium in air or in the form of tritiated water or tritiated steam in the atmosphere. (auth)

33148 (EUR–2951.f) L'APPLICATION DE LA SPECTROGRAPHIE DE FLUORESCENCE X A L'ANALYSE DES SOLUTIONS. (The Use of X-Ray Fluorescence Spectrography for the Analysis of Solutions). Vos, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1966. 12p. Dep. mn.

The analysis of solutions by x-ray fluorescence is discussed. It can be used to detect traces as well as higher concentrations in aqueous and organic solutions. Theoretically all elements with an atomic number higher than 12 are determinable. It is possible to cancel the influence of the matrix by the use of techniques such as internal or external standard, absorption edge, addition methods, or standardization by scattered radiations. (auth)

33149 (EUR–2955.i) DESCRIZIONE DI UNA APPARECCHIATURA PER LA LETTURA PRECISA DEI PROFILI DI ATTIVITA' SUI RADIOCROMATOGRAMMI. (Description of a Device for the Accurate Reading of Activity Profiles). Wagner, V.; Forcheri, S. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1966. 24p. Dep. mn.

A description is given of a simple device for reading radiochromatographs accurately. The characteristics were evaluated by examining some known activity profiles. An investigation was conducted into the possibility of applying this device to the determination of activity profiles relating to the diffusion of tracers on chromatographic sites by the zone-diffusion method for ascertaining tracer-diffusion (self-diffusion) coefficients. (auth)

33150 (IEA–105) THERMOGRAVIMETRIC BEHAVIOR OF SOME URANIUM COMPOUNDS: APPLICATION TO O:U RATIO DETERMINATION. Abrao, Alcidio (Instituto de Energia Atomica, Sao Paulo (Brazil)). Aug. 1965. 27p. Dep. mn.

Thermogravimetric studies of ammonium diuranate (ADU) samples led to the conclusion that a single composition represented ADU precipitated from nitrate or sulfate solution, and revealed the pyrophoricity of UO_2 obtained by the thermal reduction of ADU in H_2 atmosphere. A procedure for the determination of the O-to-U atomic ratio in UO_2 samples using only their thermograms obtained by the oxidative pyrolysis in air is included. The O:U ratio of uranium oxides was determined by thermogravimetric technique. The O:U ratio determined by this technique was in agreement with results obtained by other methods. A series of thermograms recorded for samples of the same batch of UO_2 gave valuable information on the stability of the oxide during aging. (J.R.D.)

33151 (IS-T–88) SEPARATION AND DETERMINATION OF TRACE METAL IMPURITIES IN RARE-EARTH-OXIDES. Hansen, Richard Kenneth (Ames Lab., Iowa State Univ. of Science and Tech.). May 1966. Contract W-7405-eng-82. 57p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

Thesis.

The separation and determination of certain trace metal impurities in some rare earth oxides was investigated. Within the degree of precision and accuracy shown by the data, nickel, copper, and magnesium were determined in the sesquioxides of gadolinium, dysprosium, holmium, erbium, lutetium, and in terbium oxide (Tb_4O_7). Low results were obtained for the determination of calcium and chromium. Possible causes for the low results were discussed. The apparent cause for low chromium results was overcome. Separation was necessary to obtain accurate results for nickel. Separation of the matrix rare earth from impurities was done by retaining the rare earth on a reversed-phase partition chromatographic column employing methylenebis(di-n-hexylphosphine oxide) on Kel-F as stationary phase and 1M nitric acid as eluent. Determination of the impurities was accomplished by atomic absorption spectrophotometry. The column was rejuvenated by

eluting the rare earth with 0.5M hydrochloric acid and returning the column to 1M nitric acid media. (auth)

33152 (ISO-SA-8) CHARACTERIZATION OF PLUTONIUM COMPOUNDS. Miller, A. G. (Isochem Inc., Richland, Wash.). May 27, 1966. Contract AT(45-1)-1851. 22p. (CONF-660615-4). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Chemical Society, Northwest Regional Meeting, Vancouver, B. C.

The installation and performance of equipment for measuring moisture content, surface area, particle size, and O_2-metal ratio of Pu-bearing oxides is described. This equipment was installed in a laboratory room containing four fume hoods that were modified to serve as gloved hoods. The information was prepared for oral presentation, and is accompanied by slides. (J.R.D.)

33153 (K-1639) GAS CHROMATOGRAPHY OF SOME CORROSIVE HALOGEN-CONTAINING GASES. Million, J. G.; Weber, C. W.; Kuehn, P. R. (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 30, 1966. Contract W-7405-eng-26. 20p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A gas chromatograph was developed for the analysis of complex mixtures of halogen and halogen-containing gases. A corrosion resistant gas density detector was employed for measurement of peaks eluted with dry air. Column design and operating conditions were selected by evaluation of resolution efficiency consistent with sample size required. Best performance was obtained with ½-in. OD (0.465-in. ID) Ni tubing, packed with 40 to 50 mesh Kel-F 300 LD molding powder containing 20 wt.% Kel-F No. 10 oil as a coating, and operated at elevated pressures. The effects of sample size, column temperature, and carrier flow rate were tested. Detection limits of about 0.2 micromole were achieved for components in mixtures containing highly reactive halogen compounds, volatile metal fluorides, and halocarbons. (auth)

33154 (NLCO-979) THE DETERMINATION OF OXYGEN IN MAGNESIUM, STEEL, AND TITANIUM: INTERNAL STANDARD TECHNIQUES IN 14-Mev ACTIVATION ANALYSIS. Twitty, Bryce L.; Fritz, Kenneth M. (National Lead Co. of Ohio, Cincinnati). June 1, 1966. Contract AT(30-1)-1156. 21p. (CONF-660611-3). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Society of Applied Spectroscopy Meeting, Chicago.

Fast neutron activation was used to determine O in Mg chips, steel bar stock, and Ti wire. In each case an isotope formed from the primary matrix material was used as an internal flux monitor: $^{25}Na(^{25}Mg(n,p)^{25}Na)$ for Mg; ^{56}Mg ($^{56}Fe(n,p)^{56}Mn$) for steel; and $^{48}Sc(^{48}Ti(n,p)^{48}Sc)$ for Ti. The effects of sample preparation, flux magnitude, atmosphere, and particle size were investigated for Mg chips. No sample weighing was required for routine analyses. In samples of mixed particle sizes and the most favorable operating conditions, the standard deviation was ±0.006% O. The Mg samples analyzed contained from 0.05% to 0.4% O. The Ti samples analyzed contained from 0.05% to 0.3% O and the standard deviation was determined to be ±0.005% O. The O level in steel samples ranged from 10 ppm to 140 ppm, and the standard deviation was determined to be ±3 ppm O. An equation for the relative self-shielding of gamma rays was derived. The O-to-internal standard gamma-ray absorption factors calculated from the equation were 0.995 for Mg, 0.981 for Ti, and 0.975 for steel. (auth)

33155 (PG-Report-177(Rev.)) MANUAL OF ANALYTICAL METHODS FOR GRAPHITE AND ASSOCIATED CARBONACEOUS MATERIALS. (Production Group, United Kingdom Atomic Energy Authority, Capenhurst (England)). 1966. 236p. Dep. BIS $8.00, HMSO 40s. 0d.

Analytical methods are described for inspection carbon products such as nuclear grade graphite and associated raw materials. Information is included on sampling procedures, pitch testing, petroleum coke testing, quantitative chemical determinations, emission spectrography, and miscellaneous analytical methods. (J.R.D.)

33156 (RFP-708) MEASURING PERCENT ALPHA IN DELTA-STABILIZED PLUTONIUM ALLOYS BY X-RAY TECHNIQUES. Jackson, R. J.; Pinkney, R. J.; McDonald, R. R. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). June 15, 1966. Contract AT(29-1)-1106. 9p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A method for measuring the percent alpha-plutonium in delta-stabilized plutonium alloys is described. The method is nondestructive and utilizes an x-ray diffractometer for the quantitative measure. (auth)

33157 (UJV-1512) THE USE OF THENOYLTRIFLUORACETONE FOR THE SUBSTOICHIOMETRIC DETERMINATION OF SCANDIUM BY ACTIVATION ANALYSIS. Kukula, F.; Krivanek, M. (Ustav Jaderneho Vyzkumu, Ceskoslovenska Akademie Ved, Rez). 1966. 15p. Dep. mn.

A substoichiometric method for extraction of Sc by theonyltrifluoracetone was worked out. Tetravalent elements with higher values of the extraction constant can be removed by a preliminary extraction using small amounts of theonyltrifluoracetone; Fe and Cu can be masked by cyanides. The method was used for the determination of Sc in $CaCO_3$, PbO, Al, and Bi. (auth)

33158 (Y-1543) SPARK SOURCE MASS SPECTROGRAPHIC ANALYSIS OF STEELS AND NICKEL ALLOYS. Franklin, J. C.; Griffin, E. B. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 6, 1966. Contract W-7405-eng-26. 14p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Spark source mass spectrography was utilized for the determination of B in steels and Ni alloys. Both visual and microphotometric methods of interpreting data were developed. The reproducibility of the microphotometer technique was calculated from standard samples and the visual technique was compared with conventional methods. (auth)

33159 (AEC-tr-6639) ACTIVATION ANALYSIS. Proceedings of the First All-Union Coordinating Conference, Tashkent, 24-28 October, 1962. Lobanov, E. M. (ed.) Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964). 136p. (CONF-621007). CFSTI $4.00 cy, $0.75 mn.

A separate abstract was prepared for each of the twenty-seven papers included. (A.G.W.)

For abstracts of individual papers see: 33160–33186.

33160 (AEC-tr-6639, pp 1-12) DETERMINATION OF LIGHT ELEMENTS IN SILICON AND OTHER MATERIALS BY NEUTRON ACTIVATION. Lobanov, E. M.; Zvyagin, V. I.; Zverev, B. P.; Blinkov, D. I. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

The reaction $^{10}B(n,\alpha)^{7}Li$ presents two methods using reactor thermal neutrons to determine trace amounts of boron in silicon. One method involves measuring the intensity of the ^{7}Li gamma line with a scintillation spectrometer. In the second method nuclear emulsions are used to record the alpha particles produced. A method is also described for determination of B in Si using the counting properties of Si single crystals. A Si junction is irradiated with a flux of thermal neutrons and the pulses generated across the load resistance in unit time are counted. A B or Cd filter is used to separate the pulses generated by $^{10}B(n,\alpha)^{7}Li$ reaction products from pulses of different origin. The B concentration is then calculated from the expression $N_B = n/(\sigma I V_{eff} f)$ where N_B is the concentration of boron, n is the pulse count/sec, I is the neutron flux, σ is the reaction cross section, V_{eff} is the effective volume, and f is the abundance of ^{10}B in the natural mixture. The distribution of B over the volume and surface of Si can be determined by irradiating the Si and a nuclear emulsion together and noting the distribution of α tracks over the emulsion area. (A.G.W.)

33161 (AEC-tr-6639, pp 13-17) STUDY OF GAMMA SPECTRA OF THERMAL-NEUTRON RADIATIVE CAPTURE BY ORE AND MINERAL SAMPLES. Aripov, G.; Krylov,

B, E.; Lobanov, E. M.; Matveev, N. S.; Romanov, M. M.; Khaidarov, A. A. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

A scintillation gamma spectrometer was used to study the γ spectra of ores and minerals irradiated by a collimated beam of reactor neutrons. Gamma spectra are shown for pyrrhotine ($Fe_{1-x}S$), scheelite ($CaWO_4$), rock salt (NaCl), and chalcopyrite ($CuFeS_2$). The spectra are to a certain extent characteristic of the mineral species and may in some cases be useful in mineral identification. Results of efforts to determine sulfur in sedimentary rocks and nickel in ore are also shown. (A.G.W.)

33162 (AEC-tr-6639, pp 18-21) POSSIBILITIES OF SETTING UP A NEUTRON-ACTIVATION ANALYSIS MODEL FOR SPECIAL-PURITY SUBSTANCES. Maslov, I. A.; Obukhov, A. P. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

A mathematical model is proposed for the determination of the impurity content of a sample by comparing its activity with a standard activity: $m_{im} = (A_{im} m_{st} B_{st})/(A_{st} B_{im})$, where A_{im}, A_{st}, m_{im}, m_{st}, B_{im}, and B_{st} are, respectively, the activities, the masses, and the chemical yields for the impurity and the standard. A mathematical relation between the relative square error of the determination and the other errors is then given. This relation is verified by physical models of neutron activation analysis. Results of a study of analysis of special-purity Si for Cu, As, Sb, Na, and Ga are shown. It is concluded that the relative reproducibility error is independent of sample purity and of the nature of the element being determined. (A.G.W.)

33163 (AEC-tr-6639, pp 22-7) MEASUREMENT OF THE VAPORIZATION RATE OF ZIRCONIUM FROM A ZrC HOT CATHODE BY THE NEUTRON-ACTIVATION METHOD. Maslov, I. A.; Obukhov, A. P. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

The hot cathodes for which the Zr vaporization rate was measured consisted of W strips coated with ZrC. The vaporized material was collected on water-cooled steel ring collectors. Then collectors and appropriate standards were placed in quartz test tubes and irradiated with a neutron flux of 3×10^{13} neutrons/cm^2/sec for 4 days and allowed to cool for three weeks before the gamma spectra were determined. The sensitivity of Zr determination by this procedure was 10^{-6} g. Possible methods of increasing the sensitivity are discussed. The first series of experiments showed that at 2000°C the rate of vaporization was as high as $(1-2) \times 10^{-9}$ g/cm^2/sec. (A.G.W.)

33164 (AEC-tr-6639, pp 28-31) NEUTRON-ACTIVATION ANALYSIS OF SPECIAL-PURITY ALUMINUM. Potapova, T. A.; Poleshchuk, T. V. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

A technique for determination of Cu, Mn, Zn, Ga, Cd, Fe, and Au in high-purity Al is based on irradiation of the Al simultaneously with standards of the impurities in a flux of 10^{12} to 10^{13} neutrons/cm^2 sec for 20 to 30 hr, followed by γ radiometry of the corresponding isotopes using a scintillation counter. Preliminary isolation of elements after irradiation was accomplished by radiochemical separation of the isotopes ^{64}Cu, ^{72}Ga, ^{59}Fe, and ^{56}Mn with suitable carriers and chromatographic isolation of the isotopes ^{69}Zn, ^{117}Cd, ^{115}Cd, and ^{198}Au. Radiometry of the isolated impurities was repeated several times to determine the half life of each isotope and to test its radiochemical purity. The sensitivity of the determination is as follows: 1×10^{-7}% for Cu, 2×10^{-7}% for Au, 5×10^{-7}% for Ga, 1×10^{-6}% for Mn, and 1×10^{-4}% for Fe. (A.G.W.)

33165 (AEC-tr-6639, pp 32-5) DETERMINATION OF NITROGEN IN ORGANIC COMPOUNDS BY FAST-NEUTRON ACTIVATION. Shamaev, V. I. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

The nuclear reaction $^{14}N(n,2n)^{13}N$ was used to determine nitrogen in organic compounds. No chemical isolation was attempted. The analyses were made by the computer technique using Sr as an inner standard. Specimens to be irradiated were prepared as a fine mixture of the material to be analyzed and strontium carbonate. Specimens with known nitrogen content were prepared analogously. The content of nitrogen was calculated from measurements of the annihilation gamma radiation from ^{13}N and the 0.387-Mev gamma activity of ^{87}Sr. The sensitivity of the analysis and the subsidiary nuclear processes that affect the sensitivity are discussed. (A.G.W.)

33166 (AEC-tr-6639, pp 36-41) NEUTRON-ACTIVATION ANALYSIS OF SILICA USING ION-EXCHANGE CHROMATOGRAPHY. Moiseev, V. V.; Kuznetsov, R. A.; Kalinin, A. I. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Procedures are described for separation of microimpurities in neutron-activated SiO_2 by ion exchange chromatography. The procedures (one for separation of 14 impurities and one for 27) separate the impurities into groups selected to eliminate interference of the γ activities of various isotopes. After separation the gamma spectra of the groups are recorded using a scintillation gamma spectrometer, and the elements are identified from the energy of the characteristic peaks. Quantitative determinations are made by comparison with the activity of standards. (A.G.W.)

33167 (AEC-tr-6639, pp 42-5) DETERMINATION OF IMPURITIES IN SILICON CARBIDE. Leushkina, G. V.; Lobanov, E. M.; Zvyagin, V. I.; Dutov, A. G. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Results of the activation analysis of SiC are tabulated. Interference caused by fast-neutron reactions in determination of Al is discussed. Other elements identified were Cr, La, Nd, Yb, Lu, W, and Re. No quantitative determinations were made. Data were insufficient to relate the color of fluorescence of SiC to the impurity content. (A.G.W.)

33168 (AEC-tr-6639, pp 46-9) ACTIVATION ANALYSIS OF SOME ORGANIC COMPOUNDS. Smakhtin, L. A.; Filippova, N. V.; Brovtsyn, V. K. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Procedures are described and results are shown for determination of manganese and bromine in gasoline and sodium and aluminum in polyethylene by neutron activation analysis. Very low concentrations of Mn and Br were determined in small samples with fairly high accuracy. Sodium was determined in polyethylene with an accuracy of ±10%. The accuracy for Al was ±20 to 30%. (A.G.W.)

33169 (AEC-tr-6639, pp 50-4) USE OF NEUTRON-ACTIVATION ANALYSIS IN PROSPECTING FOR MINERALS. Leipunskaya, D. I. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

A review of the use of neutron activation analysis in prospecting includes the following: advantages of neutron activation analysis, factors affecting the choice of radiation sources, types of compact neutron sources and their operating characteristics, minimum concentrations of some elements determined by activation analysis, problems of neutron activation analysis in situ, and methods being developed. (A.G.W.)

33170 (AEC-tr-6639, pp 55-9) DETERMINATION OF TRACE AMOUNTS OF GOLD IN ROCKS AND SEDIMENTARY FORMATIONS BY THE NEUTRON-ACTIVATION METHOD WITHOUT DECOMPOSITION OF THE SAMPLE.

Perezhogin, G. A.; Alimarin, I. P. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Means for lowering the interference in neutron activation analysis of rocks and sediments for gold are considered. Optimum irradiation and cooling times and use of resonance neutrons for irradiation are discussed. Experimental determinations were carried out using an irradiation time of 6 hr and cooling times of 7 to 8 days (2 days for rocks with low Na and K content). Samples were irradiated with and without Cd shells. Sensitivities in the range of 10^{-6} and 10^{-6}% were obtained. It is concluded that increasing the sensitivity to 10^{-7}% will require radiochemical separation. (A.G.W.)

33171 (AEC-tr-6639, pp 60-3) A MORE EFFECTIVE DETERMINATION OF GOLD IN ORES BY ACTIVATION ANALYSIS. Lobanov, E. M.; Miranskii, I. A.; Pozychanyuk, V. F.; Saifutdinova, D. G.; Khaidarov, A. A. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Means of reducing interference due to ^{24}Na, ^{76}As, and ^{59}Fe in determination of gold in ores are considered. Experiments indicated that irradiating the samples in a Cd shell reduced the activity of ^{24}Na and ^{59}Fe relative to the activity of ^{198}Au by reducing activation by thermal neutrons. The As content can be reduced by ignition of the sample at 700 to 900°C before irradiation. Under these conditions, the activity of the short-lived isotopes in the irradiated sample will have dropped to the level of the long-lived background in 7 days, and quantitative determinations are possible with Au concentrations of the order of 0.1 g/ton. (A.G.W.)

33172 (AEC-tr-6639, pp 64-6) FAST NEUTRON-ACTIVATION DETERMINATION OF SODIUM AND POTASSIUM IN SMALL POWDERED SAMPLES OF ALUMINOSILICATE ROCKS. Leipunskaya, D. I.; Putyatina, N. D. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Samples of aluminosilicate rocks to be analyzed for Na and K were irradiated together with appropriate standards in a reactor for 1 to 3 min by a flux of 10^{10} to 10^{12} neutrons/cm^2/sec. The partial β activities of the resulting ^{24}Na and ^{42}K were isolated by using an Al filter of thickness such that the intensity ratios of the β radiation recorded with and without the filter were sharply different. The contents of Na and K were calculated from the measured β activities of the sample with and without the filter and the measured activities of the standards. The disagreement between the results obtained and chemical analytical data was between 5 and 6%. (A.G.W.)

33173 (AEC-tr-6639, pp 67-9) DETERMINATION OF IMPURITIES IN BORON AND IN QUARTZ CRYSTALS BY THE NEUTRON-ACTIVATION METHOD. Lobanov, E. M.; Chanyshev, A. I.; Dutov, A. G.; Khudaiberganov, A.; Ashirov, M. G. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Boron specimens and quartz crystals were activated by irradiation in the thermal channel of a reactor. The gamma spectra were taken with a multichannel scintillation γ spectrometer. Analysis of the γ spectra showed that the boron contained Cu, Mn, and Na impurities. The content of each was determined by comparison with standards. Results were corrected for the strong absorption of neutrons in B. Quartz samples were irradiated twice—once with the total neutron spectrum and once with fast neutrons only (using Cd shielding)—to differentiate between ^{28}Al formed by slow neutrons on Al and by fast neutrons on Si. Al_2O_3 contents were determined in the range of 0.01 to 0.03%. (A.G.W.)

33174 (AEC-tr-6639, pp 70-3) DETERMINATION OF ALUMINUM IN KAOLIN CLAYS BY THE NEUTRON-ACTIVATION METHOD. Lobanov, E. M.; Chanyshev, A. I.; Dutov, A. G.; Ashirov, M. G.; Khudaiberganov, A. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

An irradiation time of 5 min and a cooling time of 2 min were used in determination of Al in kaolin clays by neutron activation. Samples were irradiated in the thermal channel of the reactor to minimize interference from ^{28}Al formed by fast-neutron reactions with Si. Samples less than 100 mg were used so that self-shielding was negligible. The Al content was calculated by comparison of the γ spectra of the irradiated sample with that of a standard. The mean deviation between the results obtained and results of chemical analysis was 13%. An apparatus was designed for continuous determination of Al in clay samples in a horizontal beam of reactor neutrons. (A.G.W.)

33175 (AEC-tr-6639, pp 74-7) DETERMINATION OF COPPER IN CORES BY ACTIVATION ANALYSIS. Lobanov, E. M.; Novikov, A. P.; Chanyshev, A. I.; Dutov, A. G.; Ashirov, M. G.; Khudaiberganov, A. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962. (1964).

Calibration graphs for use in determination of Cu in cores were prepared by irradiating samples of known Cu content and measuring the intensity of the appropriate γ lines. Either ^{66}Cu or ^{64}Cu can be used for Cu determination. Use of the short-lived ^{66}Cu is faster for single analyses, but use of long-lived ^{64}Cu is more suitable for large-scale analyses because 50 to 100 samples can be irradiated and measured simultaneously. Special procedures are required in use of ^{64}Cu to eliminate interference by ^{24}Na. Results in satisfactory agreement with results of chemical analysis were obtained. (A.G.W.)

33176 (AEC-tr-6639, pp 78-81) LARGE-SCALE DETERMINATION OF COPPER IN CORES BY THE NEUTRON-ACTIVATION METHOD. Lobanov, E. M.; Chanyshev, A. I. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

In a method for large-scale determination of Cu in cores 100 samples with 10 standards are irradiated for 2 hr in the thermal column of a reactor. The samples are cooled for 20 hr, after which the principal remaining isotopes are ^{64}Cu and ^{24}Na. The radioactivity of the samples is measured by an apparatus adapted for simultaneous counting in two channels. One channel records only γ quanta with energies greater than the maximum energy of ^{24}Na; the other channel records the total activity. Cu content is calculated from these two measurements and a calibration graph. The accuracy of the measurements is close to 10%. A semiautomatic device was designed for feeding samples to the detector; measurements of one sample takes 2 to 3 min. (A.G.W.)

33177 (AEC-tr-6639, pp 82-5) APPLICATION OF NEUTRON-ACTIVATION ANALYSIS TO THE DETERMINATION OF COPPER IN BENEFICIATION PRODUCTS. Plaksin, I. N.; Aleksandrov, Ch. A.; Starchik, L. P. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Cu in beneficiation products can be determined from both β and γ radiation from ^{64}Cu and ^{66}Cu produced in the samples to be analyzed by irradiation with neutrons from a Po–Be source. Al, Si, and Zn interfere with determination of Cu by its β activity, but the method can be used if Cu content is high or quantities of these elements are small. A scintillation gamma spectrometer is used for determination of Cu from its γ activity. Elimination of interference from ^{28}Al is discussed. The method is rapid and simple and the relative error of 2.5 to 3% is satisfactory for control in beneficiation plants. (A.G.W.)

33178 (AEC-tr-6639, pp 86-91) DETERMINATION OF RARE-EARTH ELEMENTS IN ACCESSORY MINERALS BY THE NEUTRON-ACTIVATION METHOD. Lobanov, E. M.; Babaev, A.; Nurmatov, D. Translated from Tr.

1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

A procedure was developed for quantitative determination of Ce, La, and Sm in accessory minerals. The optimum irradiation time was 10 min and the optimum cooling time was 24 hr. The induced activity was measured with a scintillation γ spectrometer. Sm was determined from the 0.104-Mev γ line of ^{153}Sm, La from the 1.597-Mev γ line of ^{140}La, and Ce from the 0.145-Mev γ line of ^{141}Ce. The presence of other rare earths in the sample was confirmed but no other quantitative determinations were made. The sensitivity of the analysis was found to be 10^{-6}, 10^{-4}, and 10^{-1}% for La, Ce, and Sm respectively. (A.G.W.)

33179 (AEC-tr-6639, pp 92-6) THE POSSIBILITY OF DETERMINING SILVER IN SOLUTION BY THE NEUTRON-ACTIVATION METHOD. Plaksin, I. N.; Petkov, P. M.; Starchik, L. P.; Stogova, G. B. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Elements that interfere with determination of Ag in solution by neutron activation are discussed. It is concluded that the only significant ones are ^{66}Cu and ^{24}Na, and procedures based on γ energy discrimination are suggested for elimination of these interferences. The procedure proposed is suitable for rapid determination of Ag in intermediate products of flotation in ore beneficiation installations. (A.G.W.)

33180 (AEC-tr-6639, pp 97-102) GAMMA-SPECTROMETRIC DETERMINATION OF CESIUM BY THE NEUTRON-ACTIVATION METHOD. Plaksin, I. N.; Belyakov, M. A.; Starchik, L. P. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

To determine Cs in minerals, the sample was activated for one hour by neutrons from a Po–Be source and allowed to cool for 20 min. The count rate due to the 128-kev gamma quanta from ^{134}Cs was then selectively recorded by a scintillation γ spectrometer. The Cs content was determined from this measurement and a calibration graph. Procedures for elimination of interference by other elements and for correction for self-absorption are suggested. The relative mean square error in a determination of 1% Cs_2O was close to 7%. (A.G.W.)

33181 (AEC-tr-6639, pp 103-7) DETERMINATION OF TANTALUM IN ROCKS AND MINERALS BY THE NEUTRON-ACTIVATION METHOD. Shiryaeva, M. B.; Salmin, Yu P. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Samples of rocks, ores, and minerals to be analyzed for Ta were irradiated together with appropriate standards in a flux of 10^{12} neutrons/cm^2 sec for 24 hr and left to cool for 4 to 6 days. The samples were then decomposed and Ta was isolated by a chemical procedure that resulted in a precipitate of Ta and Nb pentoxides carrying small quantities of Ti, W, Pt, Mo, traces of Fe, and Zr. The content of Ta was determined by the relative method from the area of the 1.12- to 1.23-Mev photopeak on a gamma spectrometer. It is concluded that activation analysis with simple radiochemical separation is convenient for determination of Ta in natural powdered samples containing 10^{-4}% or more Ta. (A.G.W.)

33182 (AEC-tr-6639, pp 108-13) FAST RADIOCHEMICAL SEPARATION IN ACTIVATION ANALYSIS OF BIOLOGICAL MATTER. Kist, A. A.; Zvyagina, L. S.; Lobanov, E. M.; Nikolaev, A. I.; Zvyagin, V. I. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Magnesium and cobalt were determined in cerebral tumors and brain tissue of rats using fast radiochemical isolation and short-lived isotopes. The irradiated samples were dissolved in nitric acid. For magnesium determination, Cu and Mn were removed by double precipitation as sulfides, and the Mg was then precipitated as the hydroxyquinolate. Mg was determined from the γ spectrum of ^{27}Mg. The isolation required 8 to 12 min and the sensitivity was 3×10^{-7} g. Cobalt was extracted as its α-nitroso-β-naphtholate; the procedure required 12 to 15 min. Co was then determined from the γ spectrum of ^{60m}Co. The determination was considered reliable but the sensitivity was low. (A.G.W.)

33183 (AEC-tr-6639, pp 114-17) DETERMINATION OF ELEMENTS OF HIGH THERMAL-NEUTRON-CAPTURE CROSS SECTIONS IN BENEFICIATION PRODUCTS BY THE NEUTRON-ABSORPTION METHOD. Plaksin, I. N.; Starchik, L. P.; Malysheva, N. G. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Some elements having anomalously high thermal-neutron-capture cross sections can be determined by measuring the density of the neutron flux emerging from the sample. A special assembly for this type determination includes a Po–Be neutron source and a slow-neutron scintillation counter. A cartridge filled with the sample to be analyzed is mounted in a flux of slow neutrons and the neutrons passing through the sample are counted. The depth of the cartridge is chosen according to the element being determined and its content. The method may be used with dry samples or with solutions. Calibration graphs are shown for Cd, B, Hg, Li, and rare earths. A similar method of analysis involves measurement of neutron absorption in the solid phase of a suspension. The method can also be used for determination of B in organic compounds. (A.G.W.)

33184 (AEC-tr-6639, pp 118-21) USE OF EXCITATION OF X-RAY FLUORESCENCE BY ALPHA-RADIATION IN THE ANALYSIS OF ORES AND BENEFICIATION PRODUCTS. Plaksin, I. N.; Belyakov, M. A.; Starchik, L. P. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

When α particles from a ^{210}Po source are used to excite x-ray fluorescence in ores and beneficiation products, the content of the relevant element can be determined from a calibration curve plotted using standards whose composition is close to that of the products being analyzed. Correction for self-absorption is necessary if the grain size of the sample is larger than the α-particle range. The dependence of the intensity of the characteristic K-series radiation of Sm on the content of SnO_2 in a mixture with quartz is shown. The method is most suitable for medium and heavy elements. (A.G.W.)

33185 (AEC-tr-6639, pp 122-5) QUALITY CONTROL OF BENEFICIATION PRODUCTS UTILIZING THE SCATTERING OF BETA RADIATION. Plaksin, I. N.; Aleksandrov, Ch. A.; Starchik, L. P.; Tomov, T. G. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

Procedures were developed for measuring the content of lead, tin, and mercury in ore beneficiation products by β-particle scattering. Dependence of the intensity of scattered β particles on the concentration of the elements can be reduced by use of filters; optimum filter thickness is determined for several ores. Effects of sample thickness, sample density, and moisture content are considered. Comparison of results obtained with results of chemical analysis gave a standard deviation of 0.20% for concentrations between 1 and 7% and 0.41% for concentrations from 7 to 42%. The analysis requires 5 to 10 min. (A.G.W.)

33186 (AEC-tr-6639, pp 126-30) DETERMINATION OF TUNGSTEN IN SOLUTIONS BY THE METHOD OF ABSORPTION OF SOFT GAMMA QUANTA. Plaksin, I. N.; Anchevskii, E. V.; Russkaya, E. I.; Starchik, L. P. Translated from Tr. 1-go [Pervogo] Vses. Koordinats. Soveshch. Aktivatsionnomu Anal., Inst. Yadern. Fiz. Akad. Nauk Uz. SSR, Tashkent, 1962, (1964).

For determination of W in solutions of ore beneficiation products by absorption of soft γ rays, a ^{170}Tm source was used. The sample to be analyzed was poured into a cylindrical Plexiglas beaker and placed in a collimated beam of β rays. The number of γ quanta passing through the sample was counted, and the content of W was determined from a calibration graph. Effects of sample volume and interfering elements are considered. The analysis required 10 to 15 min and was sufficiently accurate for plant control purposes. (A.G.W.)

33187 (ORNL-tr-1113) SMEARING AND DESMEARING IN X-RAY SMALL-ANGLE DIAGRAMS. Kratky, O.; Porod, G.; Skala, Z. Translated for Oak Ridge National Lab., Tenn., from Acta Phys. Austr., 13: 76-128(1960). 73p. Dep. mn. JCL $7.60 fs, $2.39 mf.

A method is presented for the lateral desmearing (elimination of the influence of the thickness of the line-shaped primary beam cross section); this is followed by the use of a family of curves which facilitates desmearing required by the length of the primary beam cross section, in addition to the construction of an instrument which permits desmearing by mechanical means with the use of an idea originated by Gerold; and finally a description of the practical steps for the attainment of a suitable intensity distribution in the primary beam. (M.O.W.)

33188 (ORNL-tr-1238) QUARTERLY REPORT NO. 2 [ON PHYSICAL CHEMISTRY], APRIL 1–JUNE 30, 1964. (European Atomic Energy Community. Kernforschungsanlage, Juelich (West Germany)). Translated by R. G. Mansfield (Oak Ridge National Lab., Tenn.), from a report. 14p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Methods and results are discussed concerning separation of Pu from Am and preparation of Pu(IV) solutions. Information is also included on estimation of ^{241}Am in Pu preparations by alpha pulse-height analysis, distribution of Pu(IV) between HNO_3 and solutions of trioctylphosphine oxide and tridodecylamine in diethylbenzene, stability of Pu-tridodecylamine-xylene extractions, and stability of trioctylphosphine oxide and tridodecylamine in diethylbenzene. (J.R.D.)

33189 (ORNL-tr-1240) QUARTERLY REPORT NO. 6 [ON PHYSICAL CHEMISTRY], APRIL 1–JUNE 30, 1965. (European Atomic Energy Community. Kernforschungsanlage, Juelich (West Germany)). Translated by R. G. Mansfield (Oak Ridge National Lab., Tenn.), from a report. 9p. Dep. mn. JCL $1.10 fs, $0.80 mf.

Results and discussion concerning studies of distribution coefficients of Pm, Am, and Cm between aqueous HNO_3 and mixtures of trioctylphosphine oxide, tridodecylamine, and diethylbenzene are presented along with similar information on U. Data on separation of Am from Cm by ion exchange are included (J.R.D.)

33190 (SLAC-Trans-43) SEMICONDUCTOR PRESSURE TRANSDUCERS FOR GAS MIXTURES. Nechushkin, A. M.; Belash, P. M.; Belov, V. F.; Sarkisov, A. L. Translated by J. Bradley (Stanford Linear Accelerator Center, Calif.), from Izv. Vyssh. Ucheb. Zaved. Neft. Gaz, 7: No. 11, 89-91(1964). 5p. Dep. mn. CFSTI $1.00 cy, $0.50 mn. JCL $1.10 fs, $0.80 mf.

The possibility was investigated of using semiconductor radiation counters together with α-sources in the measurement of pressure and percentage composition of gas mixtures. The technique and results are discussed. (M.O.W.)

33191 DETERMINATION OF RADIOSTRONTIUM BY SOLVENT EXTRACTION. Johnson, Walter C. Jr. (Hanford Atomic Products Operation, Richland, Wash.). Contract AT(45-1)-1350. Anal. Chem., 38: 954-5(July 1966). (RL-SA-29).

A rapid reliable radiochemical procedure for the separation of radiostrontium from a mixed fission-product matrix containing ^{144}Ce–^{144}Pr, ^{137}Cs, ^{106}Ru–^{106}Rh, ^{95}Zr–^{95}Nb ^{147}Pm, and ^{90}Y is described. The analysis can be performed in 45 minutes. The rare earths and yttrium are preferentially extracted into 1.5M di(2-ethylhexyl)ortho-phosphoric acid in toluene from a solution made 0.1M in nitric acid. After a pH adjustment to 9.5, the strontium is extracted into a 0.05M thenoyltrifluoroacetone solution in hexone and then stripped into 3.0M nitric acid, simultaneously decontaminating strontium from other major fission products. Strontium recoveries are presented as a function of pH along with a complete decontamination profile. Recoveries of 98.2% were obtained by five different analysts with a standard deviation of 1.8%. (auth)

33192 ISOTOPIC DETERMINATION OF ^{48}Ca BY PROTON ACTIVATION. Peisach, Max; Pretorius, Rene (Southern Universities Nuclear Inst., Faure, S. Africa). Anal. Chem., 38: 956-9(July 1966).

Activation with 4.75-Mev protons of calcium samples containing enriched ^{48}Ca as tracer, leads to the formation of 44-hr ^{48}Sc and 4-hr ^{43}Sc and ^{44}Sc. The ratio of these activities gives a measure of the isotopic concentration of ^{48}Ca. Other calcium isotopes do not interfere. The relative standard deviation over the concentration range from 0.18 (natural) to 4 at.% ^{48}Ca is 2.7%. (auth)

33193 RADIOCHEMICAL SEPARATIONS BY ISOTOPIC ION EXCHANGE. Tera, Fouad; Morrison, G. H. (Cornell Univ., Ithaca, N. Y.). Anal. Chem., 38: 959-64(July 1966).

Rapid separation of radioactive species, which has particular application to matrix removal in activation analysis, was studied. Ion exchange and isotopic exchange operate simutaneously to effect multitrace element separation from large amounts of a radioactive matrix element. The technique was applied to activation analysis of trace elements in barium nitrate and sodium nitrate samples. (auth)

33194 ACCURACY OF THREE METHODS FOR DETERMINATION OF OXYGEN IN POTASSIUM AT CONCENTRATIONS LESS THAN 20 p.p.m. Gahn, Randall F.; Rosenblum, Louis (Lewis Research Center, Cleveland). Anal. Chem., 38: 1014-18(July 1966).

Comparative determinations are made for oxygen in potassium at concentrations <20 ppM, for the vacuum amalgamation, vacuum distillation, and neutron activation methods, by a replicate sampling technique. The oxygen values obtained by all 3 methods show good agreement when adjusted for the effect of systematic errors (environmental contamination and method blank) and the presence of alkaline impurities other than K_2O in the potassium. Agreement of results from 3 independent analytical methods establishes the accuracy of the oxygen determination with a high degree of confidence. (auth)

33195 EMISSION SPECTROGRAPHIC DETERMINATION OF PLUTONIUM, THORIUM, AND RARE EARTHS IN AMERICIUM FOLLOWING ANION EXCHANGE SEPARATION. Barton, H. N. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Anal. Chem., 38: 1077-8(July 1966).

A method for determining plutonium, thorium, and rare earths in americium was sought because the carrier distillation methods routinely used for detection of these elements failed as their refractory oxides are not volatized from the base material during arcing of the sample. Ion exchange appeared to offer the best opportunity for simple and quantitative separation prior to spectrographic analysis. Plutonium and thorium were separated from americium by adsorption of their anionic nitrate complexes onto an anion exchange resin. Rare earths were separated by cation exchange in citrate solution or by anion exchange in thiocyanate solution. While the sample preparation is lengthy for an emission spectrographic method, the separations achieved permit detection of low concentrations of actinide and impurities. (P.C.S.)

33196 NONDESTRUCTIVE ACTIVATION ANALYSIS OF CRUDE OILS FOR ARSENIC TO ONE PART PER BILLION, AND SIMULTANEOUS DETERMINATION OF FIVE OTHER TRACE ELEMENTS. Veal, Dean J. (Phillips Petroleum Co., Bartlesville, Okla.). Anal. Chem., 38: 1080-3(July 1966).

A sensitive and reliable analysis for 1 to 100 ppB of arsenic in crude oils was developed because of the possible effect of arsenic on expensive plutonium reforming catalysts. This method determines arsenic without destruction of the sample and γ spectrometry is used to measure the 0.56 Mev γ ray from ^{76}As formed by thermal neutron capture by ^{75}As selectively and without chemical separation from the Cu, Zn, Na, Ni, and Br activities, which are determined simultaneously. Difficulties arose because some crude oils are such inhomogeneous mixtures that it was hard to obtain representative samples for analysis. It was found that repeated extractions with either 30% or concentrated sulfuric acid would not remove more than 75 to 80% of the total arsenic from some crude oils. (P.C.S.)

33197 URANIUM ISOTOPE ANALYSIS BY OPTICAL EMISSION SPECTROMETRY. Leys, J. A.; Perkins, R. E. (Minnesota Mining and Mfg. Co., St. Paul). Anal. Chem., 38: 1099-1101(July 1966).

The precision of alignment necessary for photoelectric integration of optical emission spectrometry for determination of the uranium isotopic ratios of ^{235}U, ^{236}U, and ^{238}U was attained using a standard direct reading spectrometer with slight modification. Design, operation, and performance of the spectrometer are discussed. (P.C.S.)

33198 CONTINUOUS MONITOR FOR HYDROGEN IN GASES. Walker, J. A. J.; Campion, P. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Analyst, 91: 347-9(June 1966). (TRG-Report-1046).

The construction and use of an instrument for the continuous monitoring of hydrogen in gas streams is described. Principles on which the instrument is based are the catalytic oxidation of hydrogen to water, and the subsequent determination of the water with an electrolytic hygrometer. Factors relevant to the efficient operation of the instrument for laboratory and plant conditions are discussed. Results indicate a coefficient of variation of the order of ±5% for the 80 to 1000-vpm hydrogen range. (auth)

33199 DETERMINATION OF ^{3}He IN ARGON AT LEVELS OF 10^{-12}. Melhuish, K. R.; Chapman, H. (United Kingdom Atomic Energy Authority, Caithness, Scotland). Analyst, 91: 350-4(June 1966).

The helium in the argon is first concentrated by removing the argon on an activated charcoal trap at −190°C. The helium is then transferred to a modified MS2 mass spectrometer equipped with a Vibron amplifier, in which the volume of the ^{3}He (and ^{4}He) is measured. With 1-liter samples the limit of detection is approximately 2×10^{-5} ppM by volume. Current experience on establishing the level of ^{3}He in the argon blanket gas of the Dounreay Fast Reactor is outlined. (auth)

33200 SPECTROSCOPIC DETERMINATION OF BF_3 ISOTOPIC COMPOSITION. Zakorina, N. A.; Lazeeva, G. S.; Petrov, A. A. At. Energ. (USSR), 20: 348-51(Apr. 1966). (In Russian).

A spectroscopic determination of the boron content in BF_3 is described. The boundary of the BO_2 molecule electron-oscillation band, excited by the gaseous BF_3 injected into the discharge tube, is discussed. The isotopic analysis was performed with natural isotopes enriched with ^{10}B up to 80% and ^{11}B up to 64.5 and 98%. (G.O.Y.)

33201 DETERMINATION OF THE TOTAL CORROSION PRODUCTS IN NUCLEAR REACTOR WATERS. Babkin, R. L.; Kiseleva, L. V. At. Energ. (USSR), 20: 357-9(Apr. 1966). (In Russian).

A method of determining corrosion products in reactor waters is described. The method consists of titration with EDTA to separate the metallic cations. The results of some applications of the method are summarized. (G.O.Y.)

33202 SPECTROPHOTOMETRIC DETERMINATION OF MICROAMOUNTS OF URANIUM IN ALUMINUM. Kuroha, Toshiaki; Sakakibara, Masanao; Sibuya, Seiji; Ogura, Masao (Furukawa Electric Co., Ltd., Tokyo). Bunseki Kagaku, 15: 569-72(June 1966). (In Japanese).

A method for the spectrophotometric determination of traces of uranium in aluminum metals with Arsenazo III was established, in which the uranium complex was extracted into butanol in the presence of diphenylguanidine. The disturbance from aluminum was removed satisfactorily by the addition of sodium fluoride and boric acid. One g of sample was dissolved in hydrochloric acid, and 5 g of sodium fluoride and 0.5 g of boric acid were added. After the boiling, diphenylguanidine was added and the pH of the solution was adjusted to 1.5 ± 0.2. After the addition of Arsenazo III, the complex was extracted into butanol, and the absorbance at 660 mμ was measured. As little as 0.4 to 1.0 ppM of uranium was detected and determined by the method proposed. Alternatively, a fluorometric determination after isolation of uranium by the proposed method gave values agreeing well with those obtained by spectrophotometry. (auth)

33203 DETERMINATION OF RARE EARTH ELEMENTS IN NUCLEAR FUEL MATERIALS BY ISOTOPE DILUTION METHOD. II. DETERMINATION OF CERIUM, GADOLINIUM, DYSPROSIUM, ERBIUM, AND YTTERBIUM. Komori, Takuji; Yoshida, Hiroyuki; Gunji, Katsubumi; Toida, Kimiko; Tamura, Shuzo (Japan Atomic Energy Research Inst., Tokyo). Bunseki Kagaku, 15: 589-94(June 1966). (In Japanese).

Concentrations of cerium, gadolinium, dysprosium, erbium, and ytterbium in thorium dioxides were measured by isotope dilution methods. Electromagnetically enriched isotopes of these elements (^{140}Ce, ^{155}Gd, ^{164}Dy, ^{167}Er, ^{173}Yb) were used as spike isotopes. After dissolution of the samples, known quantities of the spike solutions were added and rare earth elements were separated from the samples by thiocyanate-tri-n-butyl phosphate extraction and further divided into two groups (La to Eu and Gd to Lu) by reverse-phase chromatography. The isotopic compositions of the elements in the two groups were measured by a surface ionization type mass spectrometer, and the concentrations of cerium, gadolinium, dysprosium, erbium, and ytterbium were calculated. (auth)

33204 DETERMINATION OF HYDROGEN IN ORGANIC SOLVENTS BY PROMPT RADIATION EMITTED DURING THERMAL NEUTRON BOMBARDMENT. Ishii, Daido; Hirose, Yoji; Mori, Hideo (Univ. of Nagoya, Japan). Bunseki Kagaku, 15: 601-4(June 1966). (In Japanese).

Nondestructive determination of hydrogen in organic solvents was possible by measurement of prompt gamma radiation (2.22 Mev) from the reaction $^{1}H(n,\gamma)^{2}H$. For this reaction, fast neutrons from an Am−Be neutron source were slowed to thermal energies by the sample itself. The height of the photo-peak obtained by gamma scintillation spectrometry was found to be directly proportional to the hydrogen content. An Am−Be neutron source was suitable for this method because of its low gamma background. (auth)

33205 STUDY ON ^{210}Po ANALYSIS IN HUMAN LUNG BY ELECTROCHEMICAL DISPLACEMENT. Abe, Michiko; Abe, Siro; Takimoto, Izumi; Watanabe, Hironobu. Bunseki Kagaku, 15: 614(June 1966). (In Japanese).

The amount of ^{210}Po in human lung tissue is determined by digesting the lung sample in HNO_3, electroplating polonium from the solution, and alpha counting. The counts are compared with those from a ^{210}Po standard. (M.C.G.)

33206 POLAROGRAPHIC DETERMINATION OF POTASSIUM IN URANIUM COMPOUNDS. Tomazic, B.; Branica, M. (Inst. Ruder Boskovic, Zagreb). Croat. Chem. Acta, 37: 277-80(1965).

The a-c polarographic method is proposed for determination of potassium in precipitates of the system: uranyl nitrate−potassium hydroxide−potassium nitrate. Samples containing potassium and uranium were dissolved in 4M nitric acid, uranium was removed by continuous extraction using tetrahydropyran. After mineralization with concentrated nitric acid and hydrogen peroxide, the samples were dissolved in a supporting electrolyte: 0.075 M tetramethylammonium hydroxide and 0.075 M tetramethylammonium chloride. From 2.8 to 28 μg of potassium per ml could be determined with a standard error of 0.4 μg K/ml. The lowest gramatomic ratio K/U was 3.5×10^{-5}, i.e., 5.6 ppm of K in U. (auth)

33207 PRASEODYMIUM AND NEODYMIUM DETERMINATION BY MEANS OF THE (n,2n) REACTION. Plaksin, I. N.; Starchik, L. P.; Tustanovskii, V. T. Dokl. Akad. Nauk SSSR, 165: 1095-6(Dec. 11, 1965). (In Russian).

The gamma radiation from ^{140}Pr (0.511 Mev) and ^{141m}Nd (0.76 Mev), which are produced by the (n,2n) reaction on 5-g samples containing stable praseodymium and neodymium were used in the determination of these elements. The spectra of the activated elements in the unknown were compared with those of known-content samples treated similarly. The sensitivity of the method depends on the fast-neutron flux, and at 5×10^8 n/cm^2.sec is theoretically 2×10^{-6} and 4×10^{-6} g, respectively; the average error was found to be 4.7%. Activation was with 14-Mev neutrons. The spectra were recorded using a NaI(Tl) crystal well counter. In the experiments the flux varied from 10^8 to 7×10^8 n/cm^2.sec depending on the degree of use of the tritium target in the neutron generator. The ^{143m}Sm (0.68 Mev) is corrected, but lanthanum, europium, and gadolinium do not interfere. The samples are conveyed pneumatically from the source to the counter in 1 sec. (TTT)

33208 NEUTRON-ACTIVATION METHOD FOR DETERMINING BISMUTH IN ROCK AND ORE SAMPLES. Lobanov, E. M.; Yankovskii, A. V. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 3, 65-6(1965). (In Russian).

On irradiating Bi in a reactor, ^{210}Bi is formed as follows: $^{209}Bi(n,\gamma)^{210}Bi$. The ^{210}Bi isotope decays with a half life of 5 days by beta emission to ^{210}Po, which in turn decays with a half life of 138.4 days by alpha emission to stable ^{206}Pb. Bismuth is determined by irradiating 120 to 150 mg of unknown ore sample along with a standard at a neutron flux of 1.8×10^{13} neutrons/cm^2 · sec for a period of 2 to 8 hours. The irradiated samples are held 8 to 12 days (70% of the maximum amount of ^{210}Po is accumulated in 7 days). The induced alpha activity is counted on a ZnS (Ag) scintillation counter equipped with a photomultiplying tube. The results showed that the alpha activity is a linear function of the bismuth concentration from 0.005 to 1.5% Bi in the sample. The sensitivity of the method is 0.005%. The error is 10 to 15% compared with the results of chemical analysis. The content of natural alpha emitters such as radium, thorium, or uranium in the sample should be <0.05% for accurate results. (TTT)

33209 DETERMINATION OF SCANDIUM CONTENT IN ROCKS BY MEANS OF ACTIVATION ANALYSIS. Lobanov, E. M.; Chanyshev, A. I.; Chanysheva, T. I. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 3, 66-8(1965). (In Russian).

A 0.5-g ore sample was irradiated a period of 2 hr at a neutron flux of 1.2 neutrons/cm^2-sec, and the induced ^{46}Sc activity ($T_{\frac{1}{2}}$ = 84 days) was determined after 10 days cooling by counting on a multichannel NaI scintillation counter at the 0.89 and 1.12 Mev gamma peaks. The scandium content was determined from the amplitudes of these peaks. The statistical error did not exceed ± 3%. The sensitivity of the scandium determination could be increased to 10^{-7}% by increasing the counting time. The scandium content in the ores varied from 10^{-3} to 10^{-4}%. A large number of samples (50 or more) could be readily analyzed. (TTT)

33210 QUANTITATIVE DETERMINATION OF FLUORINE IN FLUORITE ROCK AND OF THE PRODUCTS OF ITS TREATMENT BY ACTIVATION METHOD USING POLONIUM–BERYLLIUM NEUTRON SOURCE. Lobanov, E. M.; Chanyshev, A. I.; Chanysheva, T. I. Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 3, 68-9(1965). (In Russian).

Fluorine was determined from the reaction $^{19}F(n,\alpha)^{16}N$. The reaction threshold was 1.5 Mev, and the cross section was 5.7 mb. The ^{16}N activity had a short half life of 7.35 sec. The amount of induced activity could be determined by counting all gamma energies >4 Mev on a multichannel, NaI scintillation counter. The procedure was to irradiate 1 kg of sample for 30 sec with neutrons from a Po–Be source. The induced activity was measured within 2 sec after the irradiation. The sample was counted for 30 sec. The measurements were repeated a number of times. The analysis time was <10 min with a relative error of 10%. A unit that automatically determines the fluoride content of ores was designed. (TTT)

33211 CONDUCTOMETRIC STUDY ON THE QUANTITATIVE PRECIPITATION OF PRASEODYMIUM(III) AS NORMAL TELLURITE. Prasad, Sarju; Pathak, Keshawa Chandra (Banaras Hindu Univ., India). J. Indian Chem. Soc., 43: 176-8(Mar. 1966).

Conductometric determination of Pr^{3+} was carried out at 25 ± 0.5°C by titrating against sodium tellurite solution in 10% ethanol. An overall effect of ethanol concentration on the results was studied. The sharp breaks obtained at the end point in direct as well as reverse titrations lend support to the formation of normal praseodymium tellurite (molar ratio of Pr: Te being 2 : 3). Being a simple and precise titrimetric procedure, the method is advantageous for the determination of Pr^{3+} in microquantities. (auth)

33212 SIMPLE METHOD FOR DETERMINING THE ACTIVITY OF TWO MIXED GAMMA-RAY EMITTERS. Santholzer, Vilem; Stransky, Pravoslav (Charles Univ., Hradci Kralove, Czech.). Jad. Energ., 12: 171-2(1966). (In Czech).

A graphic method suitable for relatively prompt determination of the activity of separate radionuclides in a mixture of two or three radionuclides, gamma energies of which are sufficiently different, is described. This graphic method is based on the integral spectrum and therefore has better statistics. The method is suitable for weak activities of the order of nC, and necessitates suitable standard preparations of those radionuclides to be measured. For our experiments a mixture of ^{54}Mn + ^{137}Cs with activities of 5.27 and 4.14 nC. (auth)

33213 METHOD OF ANALYSIS OF RADIOGENIC ARGON IN MINERALS BY ISOTOPIC DILUTION. Chedzhemov, G. Kh. (Lvov State Univ.). Mineral. Sb. Lvov. Geol. Obshchest. Lvov. Gos. Univ., 19: No. 1, 81-5(1965). (In Russian).

The stability of the ratio of the total quantity of ions detected by the (Russian) MI-1305 mass spectrometer to the total number of atoms entering the mass spectrometer was demonstrated previously. The exact determination of the yield of substance from the isotopic ratio is formulated after a derivation based on the analysis of ^{40}Ar. An analytical method of isotopic dilution is thus defined for the case in which an element consisting of several isotopes, instead of a single isotope, is taken to be the standard. Several examples are chosen in which Ar from samples was diluted with Ar from the air. Satisfactory results are obtained when the change in the ^{40}Ar intensity due to the concentration in air is 1.4 to 2.4% (3.7%), so that samples from 500 to 200 million years (and younger) may be studied successfully. (BBB)

33214 CHEMICAL GROUP SEPARATION IN RADIOACTIVATION ANALYSIS. Robertson, D. S. (Royal Radar Establishment, Worcestershire, Eng.). Nature, 210: 1357-8(June 25, 1966).

An analytical technique to be used in conjunction with a chemical group separation is described. The procedure was used for the analysis of single crystal specimens of Ge for Sb, Cu, and In, in order to obtain information about the concentration of several possible impurities in the samples. From the results, it was concluded that the application of a suitable chemical group separation in conjunction with radioactivation analysis can provide useful information about the extent of several impurities in a given specimen and increases the versatility of this method of analysis. (P.C.H.)

33215 SEQUENTIAL ANALYSIS OF RADIONUCLIDES IN MARINE ORGANISMS. Tsuruga, Hanato (Tokai Regional Fisheries Research Lab., Japan). Nippon Siusan Gakkaishi, 31: 651-8(Sept. 1965).

An analytical method for radioactive Fe, Co, Zn, Zr, Ru, and Ce was developed in order to monitor the radioactivities of marine organisms. Carriers for Fe, Co, Zn, Sr, Zr, Nb, Ru, Cs, and Ce were added to ashed biological samples of 0.5 to 2.0 g in weight, and the mixture was fused for 1 hour with a mixture of $KOH-K_2CO_3-KNO_3$ (2:1:1). The product was then leached with 100 ml of water. From precipitated sulfides of Zn and Ru, Ru metal and Zn oxinate were isolated. The water-insoluble residue was leached with 2N HCl after silica dehydration. The leach was evaporated and dissolved in 8N HCl. The solution was passed through an Amberlite CG (200–400 mesh, Cl form) column, and Ce, Co, and Fe were eluted with 8N, 4N, and 0.5N HCl, respectively. From the respective elutes Ce oxalate, Co anthranilate, and Fe oxinate were isolated. The observed counting rates of the final precipitates were corrected for chemical yields, based on the added carriers, and for the counting efficiencies of the counter. The gravimetric and radiometric recoveries exceeded 80%, except for a value of 61.7% for Zr. The gross contaminations of the final precipitates were less than 0.2% of the added alien activities. Plankton samples, collected from the Pacific coast of Japan in 1962 and 1964, were analyzed; it was found that 80% or more of the total activity was by $^{144}Ce + {}^{144}Pr$; the rest was $^{106}Ru + {}^{106}Rh$. (auth)

33216 COMPOUNDS OF RARE EARTHS WITH SACCHARIC ACID. Spacu, P.; Antonescu, Elena; Plostinaru, Silvia (Inst. of Inorganic Chemistry, Bucharest). Rev. Roum. Chim., 11: 327-34(Mar. 1966).

The conditions under which several compounds of rare earths with saccharic acid are formed are presented. In weak acid media, insoluble compounds are formed, but in alkaline media soluble anionic compounds appear. The formation ratio for all these compounds is 1:1. A spectrophotometric method for the determination of cerium, based on the yellow color of the corresponding soluble anionic compound, is also described. (auth)

33217 SPECTROPHOTOFLUOROMETRIC DETERMINATION OF TERBIUM AND EUROPIUM IN POTASSIUM CARBONATE SOLUTION. Taketatsu, Tomitsugu; Carey, Mark A.; Banks, Charles V. (Ames Lab., Ames, Iowa). Talanta, 13: 1081-7(Aug. 1966). (IS-1315).

The conditions for spectrophotofluorometric determination of terbium and europium, in solutions of potassium carbonate, were established. The apparent excitation and fluorescence wavelengths used, respectively, are 245 and 550 mμ for terbium and 400 and 620 mμ for europium. The fluorescence varies linearly with the concentration of terbium and europium in the range 0.3 to 70 μg of terbium/ml. Large amounts of gadolinium, lutetium, and yttrium do not interfere. Cerium(IV) interferes seriously. (auth)

33218 DETERMINATION OF INDIUM IN STANDARD ROCKS BY NEUTRON ACTIVATION ANALYSIS. Johansen, O.; Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Talanta, 13: 1177-81(Aug. 1966).

A rapid neutron activation method for determination of indium in rocks, based on 54-min ^{116m}In, is described. The method was applied to a series of geochemical standards including granite G-1 and diabase W-1. The precision is better than ±5% for samples containing more than 5×10^{-10} g indium. Good agreement with previously published values for G-1 and W-1 was obtained. (auth)

33219 SUCCESSIVE DETERMINATION OF THORIUM AND THE RARE EARTHS WITH TRIETHYLENETETRAMINEHEXAACETIC ACID. Mukherji, Anil K. (Drexel Inst. of Tech., Philadelphia). Talanta, 13: 1183-5(Aug. 1966).

Triethylenetetraminehexaacetic acid (TTHA) is proposed for the successive determination of thorium and rare earths in mixtures by titrating first for thorium at pH 2, then adding an excess of TTHA to complex the rare earth ions completely, and titrating the excess of TTHA with standard zinc solution. Xylenol Orange and 3′,3′′-bis{[N,N-bis(carboxymethyl)amino]methyl}thymolsulfonephthalein (TMS) were tested as indicators for the titration. (auth)

33220 POLAROGRAPHIC DETERMINATION OF BARIUM, STRONTIUM, AND CESIUM. Christensen, Hans Th. (Aktiebolaget Atomenergi, Studsvik, Sweden). Talanta, 13: 1203-6(Aug. 1966). (In German).

The polarographic behavior of the elements barium, strontium, and cesium in 0.1M solutions of tetraethylammonium iodide in 80% isopropyl alcohol and 20% water was studied. The possibility of simultaneously determining barium and strontium in the same medium was investigated. The results showed proportionality between the diffusion current and the concentration of barium between 8×10^{-5} and 1.5×10^{-3}M, for strontium between 7×10^{-5} and 2.3×10^{-3}M and for cesium between 7.5×10^{-5} and 1.5×10^{-3}M. (auth)

33221 EXTRACTIVE PHOTOMETRIC DETERMINATION OF BARIUM AND STRONTIUM WITH DIMETHYLSULPHONAZO DAL. Budesinsky, Bretislav; Vrzalova, Dana (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Talanta, 13: 1217-18(Aug. 1966).

Dimethylsulfonazo DAL, i.e., the dianilide of 2,7-bis(o-sulfo-p-methylphenylazo)chromotropic acid, is proposed as an extractive photometric reagent for determination of trace amounts of barium and strontium. (auth)

33222 COMPARISON OF THREE METHODS OF OXYGEN CONCENTRATION MEASUREMENT IN SODIUM. McPheeters, C. C.; Williams, J. M. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 59-60(June 1966).

33223 PULSE NEUTRON ACTIVATION-ANALYSIS DETERMINATION OF SELENIUM IN BIOLOGICAL SAMPLES. Maxia, Vera; Rollier, M. A. (Univ., Pavia, Italy). Trans. Amer. Nucl. Soc., 9: 69(June 1966).

33224 NEUTRON ACTIVATION ANALYSIS OF BLOOD SERUM. PART I. COPPER AND ZINC. Thomas, C. C. Jr.; Tercho, G. P.; Sondel, J. A. (Western New York Nuclear Research Center, Inc., Buffalo). Trans. Amer. Nucl. Soc., 9: 69-70(June 1966).

33225 MULTIPLE CARRIER ADDITION FOLLOWED BY REIRRADIATION YIELD MEASUREMENT FOR THE DETERMINATION OF ARSENIC IN HAIR AND BIOLOGICAL MATERIAL. Heydorn, K. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 70-1(June 1966).

33226 DETERMINATION OF MANGANESE IN TISSUES BY NEUTRON ACTIVATION ANALYSIS. Hahn, Kwang J.; Haven, Mary C.; Tuma, Dean J.; Ogborn, Richard E.; Quaife, Merton A. (Veterans Administration Hospital, Omaha). Trans. Amer. Nucl. Soc., 9: 71(June 1966).

33227 PHOTONUCLEAR ACTIVATION ANALYSIS WITH AN ELECTRON LINEAR ACCELERATOR. Andersen, G. H.; Guinn, V. P.; Settle, Dorothy M. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 80-1(June 1966).

33228 DETERMINATION OF ^{18}O BY ACTIVATION ANALYSIS WITH 14-Mev NEUTRONS AND THE $^{18}O(n,\alpha)^{15}C$ REACTION. Guinn, V. P. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Kleinstein, B. J.; Mull, G. C. Trans. Amer. Nucl. Soc., 9: 83(June 1966).

33229 IMPROVEMENT OF ACCURACY IN ACTIVATION ANALYSIS BY MULTIPLE-CARRIER ADDITION FOLLOWED BY REACTIVATION YIELD DETERMINATION. Heydorn, K. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 86(June 1966).

33230 SCANNING OF IMPURITIES IN METALLIC FOILS BY TWO-DIMENSIONAL ACTIVATION ANALYSIS. Menon, M. P.; Russell, H. T.; Wainerdi, R. E. (Texas Agricultural and Mechanical Univ., College Station). Trans. Amer. Nucl. Soc., 9: 86-7(June 1966).

33231 DETERMINATION OF TERBIUM, ERBIUM, YTTERBIUM, AND YTTRIUM BY NEUTRON ACTIVATION ANALYSIS. Graber, F. M.; Lukens, H. R.; Heydorn, K. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 87(June 1966).

33232 HALOGEN DETERMINATION ERRORS DUE TO RADIOLYSIS AND RECOIL IN NEUTRON ACTIVATION ANALYSIS. Lukens, H. R.; Graber, F. M.; Settle, D. M. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 88(June 1966).

33233 DETERMINATION OF MUZZLE-TARGET DISTANCE IN GUNSHOT FIRINGS BY NEUTRON ACTIVATION ANALYSIS. Krishnan, S. S. (Attorney General's Lab., Toronto). Trans. Amer. Nucl. Soc., 9: 88-9(June 1966).

33234 STABLE ISOTOPE MEASUREMENTS BY PRECISION NEUTRON ACTIVATION ANALYSIS. Corless, James T. (Univ. of Rhode Island, Kingston). Trans. Amer. Nucl. Soc., 9: 89-90(June 1966).

33235 BETA-EXCITED MECHANISM AS AN X-RAY SOURCE IN X-RAY SOLUTION ABSORPTIOMETRY. Preuss, L. E.; Bugenis, C. K.; Collins, H. (Edsel B. Ford Inst. for Medical Research, Detroit). Trans. Amer. Nucl. Soc., 9: 94(June 1966).

33236 ROUTINE DETERMINATION OF ^{147}Pm BY CARRIER-FREE TRACER TECHNIQUES. Major, W. J.; Lee, K.; Wessman, R. A.; Leventhal, L. (Tracerlab/West, Richmond, Calif.). Trans. Amer. Nucl. Soc., 9: 94-5(June 1966).

33237 DETERMINATION OF ION-EXCHANGE EQUILIBRIUM DATA BY LIQUID SCINTILLATION COUNTING. Meyer, Walter (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc., 9: 95-6(June 1966).

33238 DEUTERON ACTIVATION ANALYSIS FOR C, N, AND O IN HIGH-PURITY METALLIC SURFACES. Benjamin, R. W. (Texas Nuclear Corp., Austin); England, L. D.; Blake, K. R.; Morgan, I. L.; Houston, C. D. Trans. Amer. Nucl. Soc., 9: 104(June 1966).

33239 SENSITIVITIES FOR ^{3}He ACTIVATION-ANALYSIS DETERMINATION OF LIGHT ELEMENTS (Z = 4 TO 20). Ricci, Enzo; Hahn, R. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 104-5(June 1966).

33240 PHOTONEUTRON DETERMINATION OF BERYLLIUM AND DEUTERIUM. Guinn, V. P. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Lukens, H. R. Trans. Amer. Nucl. Soc., 9: 106-7(June 1966).

33241 DETERMINATION OF OXYGEN IN BERYLLIUM—COMPARISON OF NEUTRON ACTIVATION AND BROMINE–METHANOL METHODS. Anderson, G. H. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Kempchinsky, P. C.; Laverty, A. Trans. Amer. Nucl. Soc., 9: 107(June 1966).

33242 MONITORING OF LEACHED FUEL ELEMENTS WITH A NEUTRON GENERATOR. Ross, W. J.; Strain, J. E.; Landry, J. W. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 107-8(June 1966).

33243 USE OF SMALL NEUTRON GENERATORS AND A RECENTLY DEVELOPED SIMPLIFIED TECHNIQUE FOR REMOTE SITE ANALYSIS OF METALLIC WEAR PRODUCTS. Kuehne, F. J.; D'Agostino, M. D. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Trans. Amer. Nucl. Soc., 9: 108-9(June 1966).

33244 PRECISION OF PHOTOMETRIC TITRATION ACCORDING TO THE SUBSTITUTION METHOD. Groeneveld, E. R.; den Boef, G. (Univ., Amsterdam). Z. Anal. Chem., 219: 328-39(1966). (In German).

An example of an instrument applicable to photometric titrations according to the substitution principle, the Elko II-Photometer, was examined. A stable photoelectric circuit permits prediction of end point precision by a simple formula. Examples illustrate the usefulness of this formula together with the reproducibility of the transmission readings. Ce(IV)–Fe(II) titrations were successful in an extinction range of ΔA of only 0.01. (P.C.S.)

33245 DETERMINATION OF ^{230}Th AND ^{232}Th IN URANIUM ORES. Baechmann, K.; Hecker, A. B. H.; Lieser, K. H. (Technische Hochschule, Darmstadt, Ger.). Z. Anal. Chem., 219: 340-6(1966). (In German).

An analytical method for uranium ores was studied. ^{230}Th was determined by measuring the α activity; ^{232}Th was determined by activation analysis and measuring the activity of ^{233}Pa. In order to estimate the yield of the chemical separation ^{234}Th was added. The activity of the radionuclides was measured in the α and the β plateau of a methane flow counter. The evaluation of the activity measurements is described. (auth)

33246 DIFFERENTIAL AMPEROMETRIC DETERMINATION OF CERIUM AND VANADIUM IN CAST IRON, STEEL, AND ALLOYS. Bogovina, V. I.; Usatenko, Yu. I.; Mal'tsev, V. F. Zavodsk. Lab., 32: 412-13(1966). (In Russian).

A 0.1 to 0.5 g metal sample is dissolved in aqua regia (1 : 1), and is evaporated to H_2SO_4 fumes after adding 10 ml of H_2SO_4 (1 : 1). The filtered solution with a volume of <40 ml is provided with a rotating Pt electrode, and a lead to a saturated calomel electrode. The V(IV) is oxidized with 0.1N $KMnO_4$ at an applied voltage of +0.9 volts. The excess $KMnO_4$ is destroyed with 1 to 2 drops of a 4% $NaNO_2$ solution, which in turn is destroyed with 5.0 ml of a 30% urea solution. On adding 10 to 20 ml of an 80% potassium pyrophosphate solution, the pentavalent vanadium is titrated with a 1×10^{-2}M 8-mercaptoquinoline solution. After taking galvanometer readings, the cerium and vanadium are then oxidized with 0.1N $KMnO_4$. The Ce and V are titrated with a 0.01M solution of 8-mercaptoquinoline. V is calculated from the first titration, and cerium from the difference between the 1st and 2nd titrations. The relative error is <5%. (TTT)

33247 MEASUREMENT OF URANIUM CONTENT BY γ EMISSION DURING RADIOMETRIC ANALYSIS OF SOLUTIONS AND CONCENTRATES. Volvenkova, V. S. Zavodsk. Lab., 32: 578-9(1966). (In Russian).

After separating uranium from radium decay products and its own short-lived decay products (^{234}Th and ^{234}Pa), it was found that uranium had a soft gamma radiation that could be counted on a thin cesium iodide scintillation counter. The uranium content depended linearly on the activity of this soft gamma radiation. The best results were obtained on placing the sample within and around the crystal. The sensitivity level (3σ) for a 20 min. count was 5×10^{-3} g/l of uranium on counting 130 ml of solution placed around a crystal 40 mm in diameter. The uranium content of phosphoric acid solutions, which varied from 0.008 to 44.8 g/l of uranium, was determined by gamma counting, and was compared with the results of chemical analyses. The average deviation was ~11%. (TTT)

33248 ASSAY OF WATER FOR TRACE ELEMENTS BY NEUTRON ACTIVATION ANALYSIS. Leddicotte, G. W. (Univ. of Missouri, Columbia). 17p. (CONF-651108–2). ORAU. Gmelin, AED-CONF-65-347-2.

From Symposium on Isotope Techniques, Urbana, Ill.

Samples of lake, river, and spring water used as drinking water sources, as well as laboratory supplies of process and demineralized water and waste water, were analyzed for dissolved solids by activation analysis. A typical analysis scheme for Cu in water is presented along with tabulation of analysis of various dissolved solids in all sample types listed above. Following irradiation of the samples, two different techniques were followed for sample processing: first, a nondestructive measurement of the samples radioactivity by means of a gamma scintillation spectrometer, and second, a separation scheme to separate the radionuclides into six groups after which the radioactivity of each group was measured. The complexity of the sample and the desired elemental results from the analysis dic-

tated which procedure was employed. If quantitative results were desired, carriers in known amounts were added to the samples, and the results were corrected for the chemical yield of the separation procedure. (B.L.M.)

33249 ACTIVATION ANALYSIS IN PROCESS CONTROL APPLICATIONS. Martin, Troy C.; Prud'homme, J. T.; Morgan, I. L. (Texas Nuclear Corp., Austin). 16p. (CONF-650634-4). ORAU. Gmelin, AED-CONF-65-155-10.

From 16th Annual Mid-America Symposium on Spectroscopy, Chicago.

A system is described for the application of fast neutron inelastic scattering and neutron activation analysis to the process control of coal samples. A four channel data analysis system to measure the C and O_2 content by inelastic scattering and the Si and Al content by activation analysis is described. The results of measurements on stationary coal samples and the results of measuring O_2 and Al in a developmental liquid loop system are presented. (B.L.M.)

33250 COMBUSTION OF ^{14}C-LABELED AND TRITIUM-LABELED SUBSTANCES FOR RADIOASSAY. Scott, Benjamin F. 9p. (CONF-651115-2). ORAU. Gmelin, AED-CONF-65-350-2.

From Eastern Analytical Symposium, New York.

A method for the combustion of ^{14}C- and tritium-labeled substances for radioassay combines the two general approaches usually used: sealed tube combustion at high temperatures with metal oxides to provide oxygen and the oxygen-flask method where the sample is placed in a large flask which is purged of air with O_2 and then the sample ignited remotely. In the reported method a Vycor tube containing the sample is filled to atmospheric pressure with O_2, sealed, and placed in a tube furnace at above 850°C for 5 min. The bottom of the tube is then placed in liquid N_2 so that a vacuum is created in the still hot tube. The tube is left in the refrigerant until it can be handled with the hand; then the tip is broken off, and the combustion products rinsed out into a counting vial using a scintillation solution. For ^{14}C the procedure is modified in two ways: first, 8 mmol of Primene, a mixture of organic amines, is added to the scintillation solution to solubilize CO_2 as an amine carbonate; and second, the tube is allowed to stand without shaking for 15 min after the addition of the solvent. The method is reproducible, easy to learn, relatively fast, and is applicable to a wide variety of sample types. (B.L.M.)

33251 NUCLEAR ANALYSIS TECHNIQUES FOR INDUSTRIAL PROCESS CONTROL. Parker, Varren Jr.; Martin, Troy C.; Morgan, Ira Lon (Texas Nuclear Corp., Austin). Trans. Amer. Nucl. Soc., 9: 109(June 1966).

33252 DETERMINATION OF TRACE AMOUNTS OF TELLURIUM IN STANDARD REFERENCE MATERIALS BY NEUTRON ACTIVATION ANALYSIS. Becker, Donald A.; Smith, Gilbert W. (National Bureau of Standards, Washington, D. C.). 25p. (CONF-650405-24). ORAU. Gmelin, AED-CONF-65-431-1.

From International Conference on Modern Trends in Activation Analysis, College Station, Tex.

For the first time, neutron activation was used for elemental analysis of NBS Standard Reference Materials at the National Bureau of Standards. The reference materials were of two general types, cartridge brass and white cast iron, and were analyzed for their tellurium content. Utilizing the nuclear reaction $^{130}Te(n,\gamma)^{131}Te \xrightarrow{\beta^-} {}^{131}I$, the samples were irradiated and the ^{131}I separated by a destructive distillation and solvent extraction technique. Chemical yields were obtained through the use of ^{125}I tracer. Tellurium concentrations of 2 to 800 ppm were determined, and the results compared to the results on identical samples obtained by polarography and emission spectroscopy. (auth)

Inorganic and Physical Chemistry

Refer also to abstract 33888.

33253 (BNL-940, pp 138-41) INELASTIC NEUTRON SCATTERING BY SOLID AND LIQUID CYCLOHEXANE. De Graaf, L. A. (Reactor Instituut Delft (Netherlands)).

The diffusive motions in liquid and solid cyclohexane were investigated by using the rotating-crystal spectrometer at the Delft reactor. Scattering spectra of the solid at 165°K and of the liquid at 295 and 330°K were measured at 6 different scattering angles between 18 and 80°. The experimental results are compared with the diffusion model of Singwi and Sjölander. Above the phase transition point (186°K) the measured self-diffusion coefficients do not vary appreciably from the value $D = 5.5 \times 10^{-6}$ cm^2/sec determined at 295°K. This indicates that the motion of the protons within a molecule is more important than the motion of the molecule as a whole. (auth)

33254 (BNL-940, pp 142-8) INELASTIC SCATTERING OF THERMAL NEUTRONS FROM PRESSURIZED ETHANE. Straker, E. A.; King, J. S.; Carpenter, J. M.; Vincent, D. H. (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering).

Inelastic neutron scattering techniques were used to investigate molecular motions of ethane at room temperature. Both liquid and gaseous ethane were studied by means of pressure variation. Data at scattering angles of 90 and 22° were obtained for neutron energies in the range from 0.046 to 0.020 ev on the University of Michigan four-rotor mechanical monochromator. Triple-axis crystal spectrometer measurements for neutron energies of 0.035 and 0.064 ev were also made. These data indicate that there is no significant difference in the scattering properties of ethane in the gas and liquid state. Effects of the torsional motion of the methyl groups about the carbon-carbon bond are evident in the low angle, low energy data but are obscured at the large scattering angle. Comparison of experiment with theory indicates that a Krieger-Nelkin model which includes a harmonic oscillator representation of the torsional motion and the effects of zero-point vibrations predicts the observed data approximately. The influence of multiple scattering on the final energy distribution for both small and large scattering angles was observed and is discussed. (auth)

33255 (BNL-940, pp 149-54) APPLICATION OF THE LANGEVIN EQUATION TO THE SCATTERING OF NEUTRONS FROM LIQUID METHANE. Griffing, George W. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.).

The Langevin equation of Brownian motion is used to analyze the scattering of neutrons by liquid methane. The scattering of a neutron by a molecule in the liquid is formulated similarly to the scattering by a molecule in a gas except that the positional coordinate of the center of mass of the molecule is assumed to obey the Langevin equation. To obtain agreement with the experimental data it is necessary for the viscous damping coefficient η appearing in the Langevin equation to be treated as an adjustable parameter. The minimum momentum transfer in the experiments is 0.8Å^{-1}, and the maximum momentum transfer for which the scattering can be distinguished from that expected for a gas is 2.2Å^{-1}. Plotting the value of η needed to fit the quasi-elastic peak against the above range of momentum transfers on a semilogarithmic graph resulted in a straight line of negative slope. An extrapolation of this straight line to zero momentum transfer gave a value of 1.7×10^{13} sec^{-1} for η, in agreement with the macroscopic experimental value. It is pointed out that the analysis is, at least qualitatively, in accord with the scattering of neutrons by other liquids. There is evidence, although not conclusive, that the rotational motion is partially hindered. (auth)

33256 (CONF-660320-2) ROLE OF VIBRATIONAL EXCITATION IN ATOM SWITCHING REACTIONS. Bauer, S. H. (Cornell Univ., Ithaca, N. Y. Dept. of Chemistry). [1966]. Contract AT(30-1)-2139. 18p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Chemical Society, 151st Meeting, Pittsburgh.

The atom switching reaction, HX + DY → HY + DX, is

presumed to occur via a direct bimolecular process involving a 4-center transition state. Classical statistical mechanics, which incorporates the assumptions that Boltzmann populations are essentially maintained for all states and that equipartition holds, leads to a pre-exponential factor of the form $\frac{1}{s!}(\epsilon/kT)^s$; rough quantum mechanics calculations indicate an activation energy $\epsilon \approx$ 60 kcal/mole. The data, obtained from the shock tube measurements of D/H exchange rates between D_2 and CH_4, NH_3, H_2S, HCl, H_2 are in disagreement with both predictions. Shock tube techniques proved essential. Only by means of such a gas dynamic process can a sample of gas be heated sufficiently rapidly and homogeneously so that one may separate in time the successive flow of energy from translation and rotation to vibrations and eventually to produce chemical changes. The analytic results show that not only are there restrictions on the relative efficiency of utilizing the energy associated with the different molecular degrees of freedom, but also that the relative kinetic energy of translation plays practically no role; it is the vibrational energy of D_2 which dominates the rate of exchange. Several predictions based on this mechanism are being investigated; partial verifications were obtained. (auth)

33257 (NLCO-974) DEVELOPMENT AND APPLICATION OF THE WINLO PROCESS FOR THE PRODUCTION OF URANIUM TETRAFLUORIDE. Cavendish, J. H. (National Lead Co. of Ohio, Cincinnati). June 1966. Contract AT(30-1)-1156. 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A process was developed for the production of uranium tetrafluoride by precipitation from a chloride solution using a copper-catalyzed sulfur dioxide reduction. Hydrofluoric acid and cupric sulfate were added to the uranium-bearing chloride solution and UF_4 was precipitated by bubbling sulfur dioxide through the hot solution. The hexavalent uranium was reduced to the tetravalent state by catalytic action of the cuprous chloride ion, which is continuously regenerated from the cupric chloride ion by the addition of the sulfur dioxide. Following favorable results on a laboratory scale, the process was adapted to the reclamation of normal and enriched residues and scaled up through the pilot stage to full production size. The UF_4 produced was of high density and was easily filtered. Decontamination factors were high for most of the impurities commonly associated with the feed solutions. Uranium metal reduced from a blend of dehydrated Winlo UF_4 and standard production UF_4 was generally equivalent to the metal produced from standard UF_4 alone. (auth)

33258 (ORNL-P-2264) ANALYSIS AND SIGNIFICANCE OF RARE-EARTH OXIDES PRODUCED BY A SOL-GEL METHOD. Buxton, S. R.; Hardy, C. J.; Lloyd, M. H. (Oak Ridge National Lab., Tenn.). Apr. 26, 1966. Contract W-7405-eng-26. 12p. (CONF-660619-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif.

Rare earth oxides were prepared by a sol-gel method and their microstructure examined at various stages by metallography, electron microscopy, and x-ray spectroscopy. A rare earth hydroxide sol was prepared from the nitrate, dehydrated to a gel, and this was calcined to dense oxide at relatively low temperature under conditions that depend on the crystal form and properties required, e.g., cubic europium oxide at 1000°C, monoclinic europium oxide at 1475°C. Rare earth oxides have potential applications in the production of uniform cermets, e.g., monoclinic europium oxide in control rods in nuclear reactors, and as stand-ins for americium and curium oxides that are being produced in the national heavy element research program. (auth)

33259 (ORNL-P-2265) PREPARATION AND NATURE OF RARE-EARTH HYDROXIDE SOLS, AND IMPLICATIONS ON THE PREPARATION OF TRANSPLUTONIUM ELEMENT OXIDES. Buxton, S. R.; Hardy, C. J.; Lloyd, M. H. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 17p. (CONF-660606-5). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Nuclear Society Meeting, Denver.

A flowsheet is presented for the five stages in the preparation of sols and gels of rare earth hydroxides. The hydroxide is precipitated by the addition of a rare earth nitrate solution to a 20-fold excess of NH_4OH at 25°C. The resulting viscous paste is heated for 1 hr at 80°C during which time the apparent pH decreases and the paste turns into a water sol. The sol is formed into microspheres of gel in a column containing a long-chain alcohol, which extracts part of the water from the sol. The gel microspheres are dried and calcined at 1200 to 1475°C for 3 hr to form the oxide. The sols and gels were examined by electron microscopy to determine the size and shape of the colloidal particles. Experiments suggest that americium is more amenable to sol formation and microsphere preparation than are the rare earths but that difficulties may arise with other transplutonium elements due to radiolysis. (M.C.G.)

33260 (ORO-648, pp 103-22) FISSION PRODUCT CHEMISTRY OF SOILS. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.).

Soil properties affecting the entrance into the food chain of low-level fission products mixed with the soil were studied. Research is reported on: cation retention properties in soils and clay minerals; development and testing of a general theory of diffusion and a method for demonstrating a quantitative relationship between activity and diffusion coefficients of Na ion in bentonite-water systems. (H.G.D.)

33261 (RFP-674) ELLIPSOMETER STUDIES ON THE CLEANING AND OXIDATION OF URANIUM. Larson, D. T.; Taylor, N. W. (Rocky Flats Div., Dow Chemical Co., Golden, Colo.). June 22, 1966. Contract AT(29-1)-1106. 22p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

An investigation was conducted (with an ellipsometer) on the feasibility of studying gas-U reaction kinetics and cathodic sputter cleaning of U. A laboratory ellipsometer was constructed, and isothermal oxidation and cathodic sputter cleaning were investigated. (auth)

33262 (UCRL-14822) LATTICE DYNAMICS OF ROCKSALT-STRUCTURE ALKALI HALIDES: EIGENVECTORS AND EIGENFREQUENCIES. Karo, Arnold M.; Hardy, John R. (Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 13, 1966. Contract W-7405-eng-48. 180p. Dep. mn. CFSTI $5.00 cy, $1.00 mn.

Lattice dynamic calculations were carried out for LiF, LiCl, and the eight sodium and potassium halides. The deformation dipole model was used in constructing the dynamical matrices describing these crystals. These calculations are discussed in an earlier publication (Phys. Rev. 129, 2024 (1963)). Complete tables of eigenvalues and eigenvectors taken from these calculations are listed. Such eigendata are expected to be useful in studies of the optical properties of doped crystals, the interaction of lattice modes with imperfections, and the design and interpretation of x-ray and neutron scattering experiments. (auth)

33263 CHEMICAL COMPOUNDS OF THE RARE GASES AND THE REACTIVITY OF FLUORINE. Maldy, Jacques (CNRS, Vitry-sur-Seine, France). Ann. Chim. (Paris), 10: 455-66(Sept.-Oct. 1965). (In French).

The preparation and chemistry of compounds of the rare gases is discussed, including preparation of the first compounds of xenon, preparation and properties of F compounds (table), preparation and chemistry of O compounds (oxyfluorides, oxides, xenates, and perxenates, to include reactions in acid and alkaline solution), and preparation of complexes. Structures of principal compounds are reviewed on the basis of ir and crystallographic data (table), with sections on structures of F compounds, and structures of oxides and perxenates. Experimental studies of the nature of the bonds are outlined, including thermochemical studies in relation to other fluorides, and studies of the partial ionic character of the bonds by F nuclear magnetic resonance and by Moessbauer effect studies using ^{129}Xe. A short discussion of the particular chemical properties of F (dissociation energy, bond strength in halogens and hydrohalic acids, ionization potential, electron affinity) is given. Theoretical studies of bond formation in rare gases are then reviewed. (BBB)

33264 STABILITY OF COMPLEXES OF LACTATE ION. NOTE III. THE SYSTEMS LANTHANUM(III), PRASEODYMIUM(III), AND GADOLINIUM(III). Calabro, Giuseppe; Curro, Paola (Univ., Messina, Italy). Ann. Chim. (Rome), 56: 348-57(1966). (In Italian).

A comparative study of complexes formed by mono- and dicarboxylic acids with rare earth element ions was continued. Stability of the lactate complexes was compared with that of acetate and glycolate. Complex formation of lactate with lanthanum(III), praseodymium(III), and gadolinium(III) was investigated by potentiometric measurements of hydrogen ion concentration at 25°C and with 1M concentration of $NaClO_4$. The formation of four complexes was demonstrated for all systems, and their stability constants were determined. The higher stability of the lactate systems with respect to the corresponding acetate systems is attributed to the chelating action of lactate ion. The lactate and glycolate ligands, having the same basicity, give equally stable complexes. Comparison of the acetate, glycolate, and lactate systems showed the following stability order for each of the three cations: acetate < lactate = glycolate. For all three anions the stability increased in the order La < Pr < Gd. (BBB)

33265 PLUTONIUM: PHYSICO-CHEMICAL PROPERTIES OF ITS COMPOUNDS AND ALLOYS. Rand, M. H.; Livey, D. T.; Feschotte, P.; Nowotny, H.; Seifert, K.; Ferro, R. At. Energy Rev., 4: No. 1, 1-112(1966).

Data are tabulated and evaluated on the thermodynamic properties, densities, crystallographic structures, equilibrium diagrams, and diffusion rates of plutonium. (296 references). (M.C.G.)

33266 INFRARED SPECTRA OF AMMONIA IN THE LIQUID STATE AND IN SOLUTION IN CARBON TETRACHLORIDE WITH DIFFERENT AMOUNTS OF DEUTERIUM. Corset, Jacques; Guillermet, Jean; Lascombe, Jean (Faculte des Sciences, Bordeaux). Bull. Soc. Chim.

The study of infrared spectra of ammonia in the liquid state at room temperature between 3800 and 1100 cm^{-1} and in carbon tetrachloride solution between 3800 and 2000 cm^{-1} as a function of the degree of deuteration made it possible to assign the observed bands and to give frequencies of the majority of the fundamental vibrations and of some harmonics or combinations of the NH_3, NH_2D, NHD_2, and ND_3 molecules. A method for the isotopic determination of liquid ammonia could be deduced from this study. (tr-auth)

33267 USE OF ELECTRON SPIN RESONANCE IN BIOCHEMISTRY. Schoffa, G. (Technische Hochschule, Karlsruhe, Ger.). Chimia (Aarau), 20: 165-72(June 15, 1966). (In German).

A bibliographic review is given of the use of electron spin resonance in biochemistry. The physical fundamentals of electron spin spectroscopy are outlined. The uses of ESR in the study of complexes or chelates of transition elements, free radicals, charge-transfer complexes, and triplet states are indicated. (76 references). (J.S.R.)

33268 SCHEME OF THE ENERGY LEVELS OF URANYL IN THE LOWEST EXCITED STATE DERIVED BY MEANS OF THE ABSORPTION SPECTRA OF THE HYDROXO COMPLEXES. Baran, V. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collect. Czech. Chem. Commun., 31: 2093-2104(May 1966).

The absorption spectra of the hydroxo complexes of uranyl in the visible range were measured in various hydrolyzed systems. By comparison of these spectra with those of the free (i.e., only hydrated) uranyl ion the scheme of the energy levels in the lowest excited state was derived. The scheme contains three pure electron transitions, to which the symmetrical stretching frequencies are added. (auth)

33269 PRESENCE OF THE UO_2^+ ION IN SYSTEMS URANIUM–OXYGEN AND URANIUM–OXYGEN–CALCIUM. Leroy, Jean-Marie; Tridot, Gabriel (Faculte des Sciences, Lille). Compt. Rend., Ser. C, 262: 1376-9 (May 2, 1966). (In French).

Magnetic measurements confirmed the presence of pentavalent uranium in the semipentoxide. Experimental determination of the magnetic susceptibility of the UO_2^+ ion showed the presence of this ion, its predominant role in the oxides between $UO_{2.5}$ and $UO_{2.66}$ (U_2O_5, U_5O_{13}, and U_3O_8), and its role in certain mixed oxides of the uranium–oxygen–calcium system ($CaUO_{3.66}$, $CaUO_{3.50}$, and CaU_2O_6). The presence of tetravalent uranium in these compounds was excluded. (tr-auth)

33270 STUDY OF THE ACTION OF SULFUR DIOXIDE ON TITANIUM, ZIRCONIUM, HAFNIUM, VANADIUM, NIOBIUM, AND TANTALUM. Davignon, Leon (Faculte des Sciences, Paris). Compt. Rend., Ser. C, 262: 1380-2(May 2, 1966). (In French).

Chemical and kinetic studies of the action of sulfur dioxide on Ti, Zr, Hf, Nb, and Ta showed that this action approaches that of pure oxygen. The reaction of sulfur dioxide with V gives first the oxide V_2O_5, which is then reduced to the oxide V_2O_4. (tr-auth)

33271 FORMATION OF NEW PHASES DURING THE REDUCTION OF CERIUM OXIDE BY CARBON. Leprince-Ringuet, Francois (CNRS, Vitry, France). Compt. Rend., Ser. C, 262: 1473-5(May 16, 1966). (In French).

During the reduction of cerium oxide, CeO_2, by carbon, two oxycarbide phases were detected; one with a formula CeOC was stable at high temperature and the other, richer in carbon, was stable below 1200°C. These two oxycarbides can be hydrolyzed just as the carbide CeC_2. (tr-auth)

33272 ISOTOPE EFFECTS IN PHYSICAL ADSORPTION AND THE INTERACTION BETWEEN ARGON ATOMS AND GRAPHITIZED CARBON BLACKS. Casanova, G.; De Paz, M.; Dondi, M. G.; Klein, M. L.; Scoles, G. (Univ., Genoa). Discuss. Faraday Soc., No. 40, 188-94(1965).

Preliminary experimental values of the isotopic separation factor are reported for argon adsorbed on the P33 (2700°K) and Spheron 6(2700°K). The zero coverage separation factor and low pressure adsorption isotherms for one of the isotopes provide a method to determine consistently both the potential parameters of the surface-adatom interaction energy and the surface area of the adsorbent. This method is applied to the system Ar + P33 (2700°K). (auth)

33273 ELECTRONIC ENERGY TRANSFER PROCESSES. Bowen, E. J. (Oxford Univ.). pp 6-14 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

Various electronic energy transfer concepts reported from 1923 to the present time are reviewed. Some concepts that are discussed are resonator treatment, resonance transfer ("trivial process"), exciton, and energy transfer through singlet and triplet states. Various examples in solution chemistry, solid chemistry, and biology are cited to elucidate the modes of energy transfer. (B.L.M.)

33274 RETENTION OF ^{90}Sr, ^{45}Ca, AND ^{140}Ba BY ALUMINUM OXIDE OF LARGE SURFACE. Belot, Y.; Gailledreau, C.; Rzekiecki, R. (Commissariat a l'Energie Atomique, Paris). Health Phys., 12: 811-23(June 1966). (In French).

A bauxite of large specific area was tested for cationic exchange properties. The cationic sorption increased with pH of solution; for calcium or sodium a value of 43 m-moles/100 g at pH 12 was obtained. The bauxite was next wetted by binary solutions, where the sodium ion was the macrocomponent and the alkaline-earth ion the microcomponent. By counting strontium-90, calcium-45 or barium-140 the distribution of the microcomponent was checked at different times. An equilibrium was reached, sometimes very slowly. From equilibrium data, adsorption isotherms were plotted and selectivity coefficients computed. The alkaline-earth cations behaved like monovalent species, but their apparent binding energy was unusually high and increased with dilution on the surface of the activated oxide. Several assumptions are made to explain this behavior. (auth)

33275 INFLUENCE OF EXCIMER FORMATION ON SOLVENT-SOLUTE ENERGY TRANSFER IN ORGANIC LIQUID SCINTILLATORS. Birks, J. B.; Conte, J. M. de C.; Walker, G. (Univ. of Manchester, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 148-52(June 1966).

Excimer (excited dimer) formation occurs in all the aromatic hydrocarbon solvents used in liquid scintillators. The influence of this process on solvent-solute energy transfer was studied for a model system: 9,10-diphenyl anthracene (DPA) in 1,6-dimethyl naphthalene (DMN), diluted by heptane (Hp). Data on the fluorescence lifetimes, spectra and quantum yields and the viscosity of DMN in Hp are used to analyze the results. It is found that the energy transfer rate parameters of the excited monomer and excimer differ, but that they are independent of Hp dilution. The influence of diffusion and solvent energy migration on solvent-solute energy transfer is discussed, and a migration mechanism involving excimer formation and dissociation is proposed. (auth)

33276 COORDINATION IN SOLUTIONS. IV. ASSOCIATION CONSTANTS FOR 1:1 COMPLEXES OF Cu(II), Zn(II), Ca(II), La(III), AND Y(III) WITH ANIONS OF SALICYLALDEHYDES. Postmus, C. Jr.; Magnusson, L. B.; Craig, C. A. (Argonne National Lab., Ill.). Inorg. Chem., 5: 1154-7(July 1966).

Association constants for 1:1 complexes of Cu(II), Zn (II), Ca(II), La(III), and Y(III) are reported at 25°C and an ionic strength of 0.1M in aqueous solution. The ligands were the anions of the parent and of the 3-, 4-, 5-, 6-chloro, 3-, 5-nitro, and 3,5-dinitro derivatives of salicylaldehyde. Constants are reported for the association of La(III) with the anion of phenol, o-nitrophenol, and o,p-dinitrophenol and for Y(III) with phenol anion. The π bonding, if it occurs in the Cu(II) complexes, had no detectable effect on trends in stability. Generalized and special case treatments are presented to obtain complex constants from spectrophotometric data where three absorbing species change concentration. (auth)

33277 CRYSTAL STRUCTURE OF TECHNETIUM(IV) CHLORIDE. A NEW AB_4 STRUCTURE. Elder, Michael; Penfold, Bruce R. (Univ. of Canterbury, Christchurch, N. Z.). Inorg. Chem., 5: 1197-1200(July 1966).

Crystal structure analysis of technetium (IV) chloride established that it represents a new structure type for AB_4 compounds. Distorted octahedral units of composition $TcCl_6$ are linked to form polymeric chains, each octahedral unit sharing one edge with each of the two adjacent octahedra, while the two unshared chlorine atoms themselves form an edge. The repeating unit of the chain is a Tc_2Cl_8 unit made up of two $TcCl_4$ planar asymmetric units related to each other by a glide plane. There are three pairs of chemically distinct Tc–Cl bonds whose mean lengths are 2.24, 2.38, and 2.49 Å, respectively. A possible explanation for these differences is offered in terms of varying degrees of π bonding. (auth)

33278 SODIUM FLUORIDE–LANTHANIDE TRIFLUORIDE SYSTEMS. Thoma, R. E.; Insley, H.; Hebert, G. M. (Oak Ridge National Lab., Tenn.). Inorg. Chem., 5: 1222-9(July 1966). (ORNL-P-1898).

Phase diagrams are reported for the $NaF-LnF_3$ binary systems. Hexagonal phases of the formula $NaF \cdot LnF_3$ are formed in all $NaF-LnF_3$ systems. Above 700°C the hexagonal phases $NaF \cdot PrF_3$ to $NaF - LuF_3$ are converted to disordered fluorite-like cubic phases of variable composition. The composition limits of the cubic phase region are extended in proportion to the difference in ion size between Na^+ and Ln^{3+} and vary in breadth ranging from 9 mole % ($NaF-PrF_3$) to 25 mole % ($NaF-LuF_3$). In each case, the LnF_3-rich phase boundary was found empirically to be $5NaF \cdot 9LnF_3$ as the interstitial positions for anions become filled. Values of the fluorite unit-cell constants were calculated from ionic radii and found to be in good agreement with measured values. Unit-cube dimensions, α_0, range from a maximum value of 5.720 Å for the LnF_3-rich phase in the system $NaF-PrF_3$ to 5.425 Å for the NaF-rich phase in the system $NaF-LuF_3$. Lattice constants for the hexagonal phases $NaF \cdot LaF_3$ to $NaF \cdot LuF_3$ vary for a_0 from 6.157 to 5.967 Å and for c_0 from 3.822 to 3.523 Å. At high temperatures the $5NaF \cdot 9LnF_3$ phase displays disordering characteristic of the fluorite-like solid solutions; at lower temperatures cationic ordering takes place in the $5NaF \cdot 9LnF_3$ phases where Ln = Dy to Lu, transforming the cubic phase to an orthorhombic phase. Hexagonal $NaF \cdot LnF_3$ and orthorhombic $5NaF \cdot 9LnF_3$ compounds are partially miscible in the solid state. In the series Dy to Lu, the hexagonal phase is increasingly soluble in $5NaF \cdot 9LnF_3$, stabilizing the 5:9 phase to the extent that the lutetium compound is stable at temperatures below 300°C, the lower temperature limit of this study. Optical properties and refractive indices of the intermediate crystalline phases in the $NaF-LnF_3$ systems were determined as part of this investigation. Minimum liquidus temperatures in the $NaF-LnF_3$ systems are associated with an $NaF-NaF \cdot LnF_3$ eutectic which varies in composition only from 25 to 29 mole % LnF_3 and in temperature from 733 to 595°C. (auth)

33279 SOME SPECTRAL ANOMALIES IN NEODYMIUM AND ERBIUM AMINOPOLYCARBOXYLATE COMPLEXES. Boudreaux, Edward A.; Mukherji, Anil K. (Louisiana State Univ., New Orleans). Inorg. Chem., 5: 1280-1(July 1966).

Chelates of Nd^{3+} and Er^{3+} with triethylenetetraminehexaacetate (TTHA), ethylenediaminetetraacetate (EDTA), and trans-1,2-diaminocyclohexanetetraacetate (CDTA) ligands were prepared in solution and their electronic absorption spectra measured. Most significant effects were found with TTHA ligands. Intensity enhancements are in the order relative to the ligands: TTHA > EDTA > CDTA. (D.H.M.)

33280 PREPARATION AND PROPERTIES OF THE YELLOW POTASSIUM SALT CONTAINING XENON IN OXIDATION STATES VI AND VIII. Spittler, T. M.; Jaselskis, Bruno (Loyola Univ., Chicago). J. Amer. Chem. Soc., 88: 2942-3(July 5, 1966).

The yellow salt of the potassium-containing xenon in mixed oxidation states VI and VIII is prepared by mixing equal volumes of approximately 0.2M xenon trioxide with 5.0M potassium hydroxide and subjecting the solution to ozonolysis for 20 min. The resulting yellow salt corresponds to an apparent formula $K_4XeO_6 \cdot 2XeO_3$ (mol wt 742). This salt is explosive and very sensitive to a mechanical shock. However, it is thermally stable up to 201°C. Above this temperature it is converted to a white anhydrous potassium perxenate salt. (auth)

33281 SINGLE-CRYSTAL PREPARATION OF CUBIC RARE EARTH TUNGSTEN BRONZES. Collins, Charles V. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio); Ostertag, Werner. J. Amer. Chem. Soc., 88: 3171-2 (July 5, 1966).

Crystal growth of rare earth tungsten bronzes by electrolytic reduction of a fused mixture of rare earth tungstate and tungsten trioxide was complicated by the relatively high operating temperature, 1000 to 1200°C. Major difficulties were: Tungsten trioxide sublimes increasingly above 800°C, thus changing continuously the composition of the melt; ceramic tubes recommended to insulate the lead wire of the cathode of the melt become conducting. At 1200°C, the temperature gradient can be severe and isotherm profiles in the crystals are difficult to control. Container materials for the highly aggressive melt are hard to find. It was found to be more advantageous to melt a mixture of rare earth chloride and tungsten trioxide. All single crystals prepared were examined by x-ray diffraction methods and were analyzed for rare earth content by magnetic susceptibility measurements. (P.C.S.)

33282 REACTION OF HD^+ WITH RARE GASES. Berta, M. A.; Ellis, B. Y.; Koski, W. S. (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 44: 4612-15(June 15, 1966).

The reactions of HD^+ ions with He, Ne, Ar, and Kr were studied in a tandem mass spectrometer over an energy

range from 2 to 25 ev. The observed isotope effect was interpreted in terms of complex formation using the polarization model at low energies and the stripping model of ion-molecule reactions at higher energies. (auth)

33283 EXPERIMENTAL DETERMINATION OF THE DISPROPORTIONATION OF HYDROGEN ISOTOPES IN WATER. Friedman, L.; Shiner, V. J. Jr. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 44: 4639-40(June 15, 1966). (BNL-10044).

Experimental results are presented from a mass-spectrometric study of the disproportionation of deuterium and hydrogen in water over a range of temperatures. (B.G.D.)

33284 ISOTOPE SHIFTS AND SPIN COUPLING IN THE PROTON MAGNETIC RESONANCE OF DEUTERATED AMMONIUM IONS. Fraenkel, Gideon (Ohio State Univ., Columbus); Asahi, Yutaka; Batiz-Hernandez, H.; Bernheim, R. A. J. Chem. Phys., 44: 4647-9(June 15, 1966).

An investigation of proton spin-spin coupling in ammonium ions by means of deuterium substitution, in which unusual isotope chemical shifts were observed, is reported. (B.G.D.)

33285 ENERGY DIFFERENCES FROM THE INTEGRAL HELLMANN-FEYNMAN FORMULA: APPLICATION TO HeH^+. Hayes, Edward F.; Parr, Robert G. (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 44: 4650-1 (June 15, 1966).

Results of calculations of the change in electronic energy (ΔE_1) in the Born-Oppenheimer approximation, given by the integral Hellmann-Feynman formula, for HeH^+ at several increments of the internuclear separation are presented. (B.G.D.)

33286 FLASH PHOTOLYSIS OF H_2O_2 VAPOR IN THE PRESENCE OF D_2, Ar, AND $H_2{}^{18}O$. Greiner, N. R. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 45: 99-103(July 1, 1966). (LA-DC-7741).

The flash photolysis of H_2O_2 by itself, and in the presence of D_2, Ar, and $H_2{}^{18}O$, was studied by the technique of kinetic absorption spectroscopy. The only observable primary products were $OH(^2\Pi^{\frac{3}{2}})$ and $OH(^2\Pi^{\frac{1}{2}})$. These ground-state levels were populated in a ratio of ~1 : 1, respectively, conforming to what is observed with the halogens. The contribution of reaction (a) to the primary process was shown in a direct way to be no more than 20% of that of (b). Reaction (c) followed by (d) was shown to make no significant contribution to the OH concentration during the time of the experiments (<200μ sec): (a) H_2O_2 (singlet) $\xrightarrow{h\nu}$ $H_2O(^1A_1) + O(^1D)$, (b) $\rightarrow 2\ OH(^2\Pi)$, (c) $\rightarrow H_2O(^3A_1) + O(^3P)$, (d) $O(^3P) + H_2O_2$ (singlet) $\rightarrow OH(^2\Pi) + HO_2$ (doublet), (e) $OH(^2\Pi) + H_2O_2$ (singlet) $\rightarrow H_2O(^1A_1) + HO_2$ (doublet). Thus, this technique is a convenient one for directly observing reactions of OH. An upper limit to the rate constant of (e) at room temperature was determined to be $5.8 \pm 1.8 \times 10^{-14}$ cm^3 molecule$^{-1}\cdot$ sec^{-1}. Conditions for generating vibrationally hot molecules in the primary photolytic step are discussed. (auth)

33287 HYPERFINE INTERACTIONS IN THE ELECTRON SPIN RESONANCE OF HYDRATED ELECTRONS. Fueki, Kenji (Univ. of Nagoya, Japan). J. Chem. Phys., 45: 183-4(July 1, 1966).

An attempt was made to interpret the hyperfine structure in the electron spin resonance of hydrated electrons observed at low temperatures. The unpaired electron spin distribution was calculated with the orthogonalized wavefunction on the basis of the model presented. It was found that the unpaired electron is mainly localized on the O-H bonds which point toward the center of a cavity and that a sharp peak in the wavefunction occurs in the vicinity of the oxygen nucleus. A calculation was also made of the linewidth in the ESR spectrum of trapped electrons in deuterium oxide. (auth)

33288 SHIFTS IN THE ESR SPECTRAL PARAMETERS OF ATOMIC HYDROGEN AND DEUTERIUM IN FROZEN ACIDS. Marshall, S. A. (Argonne National Lab., Ill.); Gabriel, J. R.; Serway, R. A. J. Chem. Phys., 45: 192-4(July 1, 1966).

The ESR spectra of atomic hydrogen and deuterium trapped in frozen acids were reinvestigated in an effort to determine whether systematic shifts in the spectral parameters exist for this neutral S-state atom. Following the example of Livingston, Zeldes, and Taylor, Partially deuterated perchloric, phosphoric, and sulfuric acids were studied after γ irradiation at 77°K. Breit-Rabi expressions that take account of the nuclear quadrupole coupling energy were used in treating the data. This study discloses g-value shifts of −0.00019, −0.00016, and −0.00012 and relative A-value shifts of −0.94%, −0.61%, and −0.38% from the free-gas values for the three acids, respectively. For perchloric and sulfuric acids, nuclear quadrupole coupling energies of 0.18 and 0.13 Mc/sec, respectively, were obtained. The possibility of 1s and $3dz^2$ mixing in the hydrogen-atom ground term due to crystalline electric fields is discussed. (auth)

33289 TIME-OF-FLIGHT DETERMINATIONS OF ELECTRON DIFFUSION COEFFICIENTS AND ELECTRON DRIFT VELOCITIES IN ETHYLENE, WATER VAPOR, AND IN HYDROGEN. Hurst, G. S.; Parks, J. E. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 45: 282-95 (July 1, 1966). (ORNL-P-2044).

The time-of-flight method for the determination of electron diffusion coefficients D and drift velocities w of electrons in gases has been improved in two essential ways. First, an accurate method of measuring all fluctuation in the time-of-flight distribution, except that due to the diffusion process itself, was developed. Second, a data analysis procedure was worked out in which the effects of instrumental fluctuations are removed and accurate values of the parameters D and w are found from a generalized least-squares procedure making use of a digital computer. Distortions in the electron time-of-flight distributions arising out of electron losses during detector dead times were calculated by assuming that single-electron detection follows Poisson statistics. This assumption was examined experimentally and was not found to be in error. Application of the improved method was made to ethylene, ethylene–water vapor mixtures, and hydrogen over the range of E/P from 0.01 to 1.0 v cm$^{-1}\cdot$ torr^{-1}. Independent measurements of the quantities D and w were made; the ratios D/w were compared with theory in the region of thermal electron energies. The ratio of the momentum transfer cross sections for H_2O compared to ethylene was essentially the same whether use was made of D(E/P) or w(E/P) data in the region of thermal energies. In the cases of ethylene and ethylene–water vapor mixtures, it was found that the value of D/w for thermal electrons was 12% higher than the theoretical value. (auth)

33290 SELF-CONSISTENT-FIELD CALCULATION OF THE ENERGY OF HeH^+. Gallup, G. A.; McKnight, M. S. (Univ. of Nebraska, Lincoln). J. Chem. Phys., 45: 364-6(July 1, 1966).

The use of the exact solutions of the one-electron–two-nucleus problem as a basis set of functions for SCF calculations is investigated for the HeH^+ ion. The calculations are made with both scaled and nonscaled functions. The best energy obtained here is −3.345 a.u. at an internuclear distance of 1.40 a.u. The conclusion is that these functions form an only moderately good basis set for such calculations. Their conditioning to the problem can only partially overcome their lack of completeness when continuum states are omitted. (auth)

33291 NEPHELAUXETIC PARAMETERS IN THE SPECTRA OF LANTHANIDE(III) COMPLEXES. Barnes, John C. (Queen's Coll., Dundee, Eng.). J. Chem. Soc., No. 6, 667-8(1966).

A statistical analysis was applied to the calculation of the nephelauxetic parameter $d\beta$, which has been used in interpretation of the f–f spectra of tervalent lanthanides. It was concluded that data of ordinary accuracy do not yield very significant estimates of $d\beta$ or of the ground-state stabilization $d\sigma$. Both practical and theoretical difficulties are involved. (auth)

33292 QUINQUEVALENT PROTACTINIUM, NIOBIUM, AND TANTALUM NITRATES AND NITRATO-COMPLEXES. Brown, D.; Jones, P. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., No. 6, 733-7 (1966).

Hexanitratoprotactinates(V), $M^{I}Pa(NO_3)_6$ (M^{I} = Cs, NMe_4, and NEt_4), were prepared by reaction of the hexachloroprotactinates(V) with liquid dinitrogen pentoxide at room temperature. The niobium(V) and tantalum(V) hexachloro analogs form oxytetranitrato-complexes, $NMe_4M^{V}O(NO_3)_4$ (M^{V} = Nb and Ta), under similar conditions. Protactinium (V) halides react with fuming nitric acid, yielding the hydrated oxynitrate $PaO(NO_3)_3 \cdot xH_2O$ ($1 < x < 4$), which is probably polymeric. Dinitrogen tetroxide reacts with protactinium(V) halides in anhydrous methyl cyanide to give the dimeric, solvated oxynitrate $Pa_2O(NO_3)_8 \cdot 2MeCN$, whereas liquid dinitrogen pentoxide converts the pentahalides and freshly prepared hydroxide, but not the pentoxide, into the acid hexanitrato-complex $HPa(NO_3)_6$. Some chemical properties and the infrared spectra of the compounds are reported. (auth)

33293 COMPLEXES OF URANIUM AND THORIUM TETRAHALIDES WITH OXYGEN-DONOR LIGANDS. Bagnall, K. W.; Brown, D.; Jones, P. J.; du Preez, J. G. H. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., No. 6, 737-41 (1966).

Thorium and uranium tetrachloride form complexes with dimethyl sulfoxide (DMSO), $ThCl_4 \cdot 5DMSO$ and $UCl_4 \cdot 3DMSO$, respectively, and with hexamethylphosphoramide (HMPA), $MCl_4 \cdot 2HMPA$ (M = Th and U). The dimethyl sulfoxide complexes undergo thermal vacuum decomposition to give $ThOCl_2$ and U_3O_8, respectively, whereas the HMPA complexes sublime above 200°C. The corresponding tetrabromides form the complexes $MBr_4 \cdot 6DMSO$ (M = Th and U), $ThBr_4 \cdot 3HMPA$, and $UBr_4 \cdot 2HMPA$. Vacuum thermal decomposition of $UBr_4 \cdot 6DMSO$ leads to the formation of $UO_2Br_2 \cdot DMSO$ at 140 to 170°C and finally a mixture of U_3O_8 and UO_2Br_2. $ThBr_4 \cdot 6DMSO$ decomposes directly to $ThOBr_2$. Thermal decomposition of $ThBr_4 \cdot 3HMPA$ yields $ThBr_4 \cdot 2HMPA$ above 150°C, which, like $UBr_4 \cdot 2HMPA$, sublimes above 250°C. Some chemical properties, infrared spectra, and magnetic susceptibilities are reported. (auth)

33294 COMPLEXES OF URANYL CHLORIDE AND THORIUM AND URANIUM TETRACHLORIDES WITH DICARBOXYLIC ACID AMIDES. Bagnall, K. W.; Brown, D.; Jones, P. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., No. 6, 741-4 (1966).

NNN'N'-Tetramethyl-malonamide (TMMA), -αα-dimethylmalonamide (HMMA), -glutaramide (TMGA), and -3,3-dimethylglutaramide (HMGA) complexes with uranyl chloride and with thorium and uranium tetrachloride were prepared in acetone. These have the compositions $UO_2Cl_2 \cdot 1.5TMMA$ (or TMGA), $UO_2Cl_2 \cdot HMMA$ (or HMGA), $ThCl_4 \cdot 2TMMA$, $ThCl_4 \cdot 1.5TMGA$ (HMMA or HMGA), $UCl_4 \cdot 1.5$ TMMA (TMGA or HMGA), and $UCl_4 \cdot HMMA$. Some chemical and physical properties of the complexes are reported. (auth)

33295 NEPTUNIUM NITRATES. Laidler, J. B. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., No. 6, 780-4 (1966).

Hydrated neptunium-(IV), -(V), and -(VI) nitrates, $Np(NO_3)_4 \cdot 2H_2O$ (grey), $NpO_2NO_3 \cdot H_2O$ (green), $NpO(NO_3)_3 \cdot 3H_2O$ (pink), and $NpO_2(NO_3)_2 \cdot 6H_2O$ (pink), have been prepared from aqueous nitric acid. Solvated neptunium-(IV) and -(VI) nitrates. $Np(NO_3)_4 \cdot xN_2O_5$ ($x \sim 1.2$) (off-white) and $NpO_2(NO_3)_2 \cdot N_2O_5 \cdot H_2O$ (pale pink), have been prepared by reaction of neptunium tetrachloride and neptunium trioxide hydrate, respectively, with dinitrogen pentoxide. The neptunium tetranitrate dimethylacetamide (DMA) complex. $Np(NO_3)_4 \cdot 2.5$ DMA (grey-green), has been prepared by reaction of the dihydrate with the ligand, or from the corresponding chloride complex and silver nitrate in methyl cyanide. The attempted preparation of neptunium (V) nitrato- and oxynitrato-complexes was unsuccessful. Magnetic properties, infrared spectra, and some x ray diffraction measurements are also presented. (auth)

33296 OXIDATION OF P.G.A. GRAPHITE BY TRACE MIXTURES OF CO_2–CO IN HELIUM. Bourke, P. J.; Gray, M. D.; Denton, W. H. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy: Pt. A and B, 20: 441-50 (June 1966).

The reaction rates of a specific nuclear grade of graphite with CO_2 and CO were measured, firstly, under conditions shown to be free of any diffusional control and secondly, in the presence of helium pressures which introduced appreciable diffusional control. CO_2 and CO pressures varied between 10^{-6} and 10^{-3} atm and temperatures between 900 and 1000°C. The results are analyzed in terms of simultaneous diffusion and reaction theory for a porous medium. This theory is found to give a satisfactory interpretation of the results. The chemical reaction-rate constant, the inhibitive effect of CO, the activation energy, and the effective diffusion coefficient are determined. Measurements were also made of the amounts of oxygen adsorbed on graphite before reaction rates become steady. (auth)

33297 STUDIES ON IONIC STATES OF RUTHENIUM BY HIGH-VOLTAGE ELECTROPHORESIS. Ohyoshi, Akira; Ohyoshi, Emiko; Senoo, Muneaki; Shinagawa, Mutsuaki (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 3: 237-42 (June 1966).

As a method of rapid separation, high voltage electrophoresis (H.V.E.) was applied to analyze various ionic species of Ru(III) and Ru(IV) present in solutions. Change of the ionic forms in solution after preparation, and as well as their ultimate equilibrium state, were investigated in chloride media. In a similar manner, the effect of complexing agents, i.e., lactic acid, oxalic acid and nitrilotriacetic acid, on the ionic forms of Ru(III) and Ru(IV) were surveyed. The results obtained were as follows: (1) Various ionic species of ruthenium coexisting in a dilute hydrochloric acid solution separated into four or five zones of migration in the case of Ru(III) and six or seven zones in the case of Ru(IV), after periods depending on their mobility. (2) Using an equilibrated sample, it was found that the ionic species practically did not change during a separation time of 5 to 18 min. Consequently, one can follow the kinetic changes of the ionic species if the reaction is not too high for neglecting reactions occurring during the elapse of a few minutes. (3) From differences in ratio between the relative amounts of several migrated ionic species according to Cl^- or OH^- concentration, it was attempted to estimate the composition of Ru(IV) chlorocomplexes. (4) In complexing media, the ionic forms involving Ru(III) did not change, while those of Ru(IV) clearly changed due to the formation of complexes. This behavior indicated a difference between Ru(III) and Ru(IV) in the grades of complex formation. (auth)

33298 THE ENRICHMENT OF THE STABLE ISOTOPE ^{34}S IN THE SYSTEM PYRIDINE–PHOSPHORIC ACID–WATER–SULFUR DIOXIDE. Stiehl, G.; Muehle, K.; Wetzel, K. (Institut fuer Stabile Isotope, Leipzig). Kernenergie, 9: 106-7 (Mar. 1966). (In German).

A study was made to find a system for the exchange of sulfur isotopes that permitted a thermal phase reversal. The results obtained with various ratios of the system constituents are tabulated. The results showed that with increasing phosphoric acid concentration in the liquid phase and decreasing pH value the total separation factor decreased. With use of this system a thermal phase reversal was possible without chemical additions. (J.S.R.)

33299 CHEMISTRY OF THE GROUP 0 ELEMENTS: THE NOBLE GASES. Lambert, C. A. (Univ. of Leicester, Eng.). Leicester Chem. Rev., No. 7, 7-11 (1965).

Discovery of oxygen and fluorine compounds of some of the noble gases is traced and recent developments in the chemistry of these compounds are reviewed. Formation of the first simple rare gas compound, XeF_4, was closely followed by that of the di- and hexafluorides. Two theories proposed to explain the occurrence of the noble gas compounds are discussed. Both concepts arrive at the same structural formulae for XeF_4 and XeF_2. Xenon hexafluoride,

however, brings the two theories into striking conflict. According to the valence bond theory, there are 14 electrons participating in the bonding, consisting of 6 electron-pair bonds and one lone-pair, which, clearly, cannot be arranged to give a symmetrical octahedral structure. Depending on the position of the lone-pair the structure will be that of an asymmetric octahedron. This is contrary to the evidence of experience; all other known hexafluorides adopt regular octahedral structures. Compounds of Kr and Rn are also discussed, as are future trends in the field. (TCO)

33300 AMMONIATES OF URANIUM TETRAFLUORIDES. Berthold, H. J.; Knecht, H. (Univ., Mainz). Naturwissenschaften, 53: 305(June 1966). (In German).

The effects of NH_3 on water-free UF_4 was investigated. If the UF_4 is reacted with liquid NH_3 at room temperature under pressures of approximately 10 atm, an ammoniate of uranium tetrafluoride is formed. The blue-green compound contains 4.2 to 4.6 M of NH_3. The higher ammoniates could be decomposed by heat and vacuum. The blue-green ammoniate is crystalline and has a characteristic diffraction pattern. In air it releases a part of its ammonia. The bright green monoammoniate is x-ray amorphous and shows no visible modification in air. (J.S.R.)

33301 COMPLEX COMPOUNDS OF URANYL IONS WITH THE 2,2'-DIPYRIDYL, 1,10-PHENANTHROLINE, AND o-, m-, AND p-AMINOBENZOIC ACIDS. Ripan, Raluca; Sacelean, Viorel (Institut de Chimie, Cluj). Rev. Roum. Chim., 11: 321-6(Mar. 1966). (In Rumanian).

The complex compounds of the uranyl ions with heterocyclic diamines, 2,2'-dipyridyl and 1,10-phenanthroline, and o-, m-, and p-aminobenzoic acids were synthesized. The complexes were formed by using the uranyl aminobenzoate and the respective diamines in methanol or by using uranyl nitrate, amino acid, and the diamine in methanol or in methanol–water systems. In the case of p-aminobenzoic acid, the same combinations were obtained as with the first method by replacing the pyridine of $UO_2(p\text{-}H_2N-C_6H_4-COO)_2 \cdot 2Py \cdot 2H_2O$ by the two amines. (tr-auth)

33302 COMPLEX SALTS OF 5-NITROBARBITURIC ACID. IV. COMPLEXES OF 5-NITROBARBITURIC ACID WITH LANTHANUM AND PYRIDINE GROUP BASES. Poni, Margareta P.; Bostan, Marcel; Iorga, Nicolae (Institut de Chimie Macromoleculaire Petru Poni, Roumania). Rev. Roum. Chim., 11: 343-8(Mar. 1966). (In Rumanian).

Complexes of 5-nitrobarbituric acid with lanthanum and the pyridine bases, α, β, γ-picoline, 2,4-, and 2,6-lutidine, and 2,4,6-collidine were synthesized. The areas of stability, the reaction order, and the activation energy of the reactions occurring during thermal treatment were established by using thermogravimetric and thermodifferential analyses. (tr-auth)

33303 CERIUM-THERMAL REDUCTION OF SAMARIUM OXIDE. Gvelesiani, G. G.; Bagdavadze, D. I. (Inst. of Metallurgy, Academy of Sciences, Georgian SSR). Soobshch. Akad. Nauk Gruz. SSR, 42: 151-8(Apr. 1966). (In Russian).

The vapor pressure of Sm metal was determined for the reaction Sm_2O_3 (solid) + 2 Ce (liq) → 2 sm (gas) + Ce_2O_3 (solid). The results can be described by the equation: $\log P_{mm} = 8.03 - 10667/T$ (from 1217 to 1473°K). The free energy of the reaction can be described by the equation: $\Delta Z^0_T = 97{,}600 - 47.12\ T$ (from 1217 to 1473°K). The optimum conditions for the process were a mole ratio of $Ce/Sm_2O_3 = 2.75$, a temperature of 1200°C, a holding time of one hour, a briquetting pressure of 2500 kg/cm² (depending on the degree of oxidation of the cerium metal), a powder size of 0.5 to 1 mm, and a vacuum of 10^{-3} mm Hg std. (TTT)

33304 REACTIONS OF YCl_3 WITH $Rb_2C_2O_4$ AND $Cs_2C_2O_4$ IN AQUEOUS SOLUTIONS. Modebadze, M. E.; Davitashvili, E. G. (Melikishvili Inst., Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 42: 333-40(May 1966). (In Russian).

The $YCl_3-Rb_2C_2O_4-H_2O$ and $YCl_3-Cs_2C_2O_4-H_2O$ systems were studied by determining the solubility, by measuring the solution pH, and by analyzing the solid phases. Normal yttrium oxalate $Y_2(C_2O_4)_3 \cdot 10\ H_2O$ was formed in both systems at a ratio of $Me_2C_2O_4$ to $YCl_3 = m < 1.25$. At values of $m > 2$ a complex salt was formed with the composition $Me\ [Y(C_2O_4)_2] \cdot x\ H_2O$, where Me is Rb or Cs. Both of these complex compounds were soluble in an excess of the corresponding alkali oxalate with the solubility decreasing on going from the rubidium to the cesium salt. The existence of the complex salts was further confirmed by x-ray analysis. (TTT)

33305 LANTHANO- AND CERITHERMAL REDUCTION OF THULIUM OXIDES. Gvelesiani, G. G.; Bagdavadze, D. I. (Inst. of Metallurgy, Georgian SSR). Soobshch. Akad. Nauk Gruz. SSR, 42: 427-34(May 1966). (In Russian).

Tm_2O_3 was reduced by La or Ce metals according to the following equation: Tm_2O_3 (solid) + 2 La_{liq} (Ce_{liq}) → 2 Tm (gas) + $La_2O_{3\,sol}$ ($Ce_2O_{3\,sol}$). The equilibrium vapor pressure P was determined by an effusion method: $\lg P_{mm} = 12.695 - 20200/T$ at 1490 to 1673°K for reduction with La metal, and $\lg P_{mm} = 12.036 - 19000/T$ at 1494 to 1673°K for reduction with Ce metal. The free energies were found to be $\Delta Z^0_T = 18430 - 89.82T$ for the La reduction, and $\Delta Z^0_T = 173850 - 83.78T$ for the Ce reduction. The optimum conditions for the reduction of Tm_2O_3 with La metal were a mole ratio of $La/Tm_2O_3 = 2.5$, a temperature of 1400°C, a reaction time of 95 minutes, a briquetting pressure of 5000 kg/cm², and a vacuum of 10^{-3} mm Hg std. With Ce metal the optimum conditions were a mole ratio of $Ce/Tm_2O_3 = 2.75$, a temperature of 1400°C, a reaction time of 95 minutes, a briquetting pressure of 5000 kg/cm², and a vacuum of 10^{-3} mm Hg std. (TTT)

33306 THEORY OF THE DYNAMICAL JAHN-TELLER EFFECT IN STRONG COUPLING. Fang, Li-zhi; Ou, Zhi. Wu Li Hsueh Pao, 22: 471-86(Apr. 1966). (In Chinese).

The dynamical Jahn-Teller effect is treated in the case of strong coupling for which the static distortional energy of electrons is larger than the energy of a typical vibrational quantum. A perturbation method which applies to strong coupling is developed. The eigenfunction and eigenvalue are expanded as a power series of the ratio of the vibrational quantum to the static distortional energy. The Jahn-Teller effect of the Γ_8 state of an O_h point group is dealt with explicitly and the energy levels of electronic-vibration system are obtained. The theory is employed to interpret the experimental results obtained from the infrared and Raman spectra of TcF_6 and ReF_6. (auth)

33307 STRUCTURAL SYMMETRY AND ELECTRONIC STRUCTURE IN ABSORPTION SPECTRA OF URANYL COMPOUNDS. Umreiko, D. S. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 2: 465-7(May 1965). (In Russian).

The dependence of the structure of absorption spectra of uranyl compounds on the symmetry of the nearest surrounding structure of the UO_2^{2+} ion was considered. They are in good agreement for a number of solutions studied. Departing from the concept of the possibility of the existence of several excited electronic states of the ion UO_2^{2+}, the assumption of the nature of these states and causes of fluorescence quenching are set forth. (auth)

33308 NUCLEAR MAGNETIC RESONANCE IN CHEMISTRY. Proceedings of a Symposium held at Cagliari, Sardinia, Italy in September, 1964. Pesce, Biagio (ed.). New York, Academic Press, 1965. 404p. (CONF-640930).

The book contains forty-four papers from a symposium held at Cagliari, Sardinia, Italy. The aim of the symposium was to survey the development of nuclear magnetic resonance in chemical studies, past achievements, current trends, future posibilities, and to present a wide range of problems to which NMR was applied. (D.H.M.)

33309 TEMPERATURE JUMP KINETIC STUDIES OF SOME POLYCATION AND POLYANION SYSTEMS. Whit-

taker, Mack Page. Salt Lake City, Univ. of Utah, 1966. 84p.

Thesis.

Kinetic studies were carried out on three polyion systems. Rate constants for the formation of the polymeric hydrolysis products of the boric acid, uranyl, and vanadate systems were calculated and possible reaction mechanisms proposed. The two experimentally observed relaxation times for aqueous boric acid solutions were identified with reactions in which $B_3O_3(OH)_4^-$ and $B_5O_6(OH)_4^-$ were formed. The values for the average rate constants were calculated to be 3.2×10^4 M^{-2} sec^{-1} and 2×10^2 M^{-2} sec^{-1} for the formation of the trimer and pentamer respectively. The decomposition rate constants for the two polymeric species were, within experimental error, the same, 60 sec^{-1}; this indicates that the rate determining step in both cases is the breaking of a boron-oxygen bond. The values of the rate constants for reactions in which $(VO_2)_2(OH)_5^{-3}$ and $(VO_2)_3(OH)_6^{-3}$ were formed in aqueous basic vanadate solutions were calculated to be 3.2×10^4 M^{-1} sec^{-1} and 5×10^2 M^{-1} sec^{-1}. The rate constant value 6.4×10^{-4} M^{-1} sec^{-1} calculated for the dimerization of uranyl ion is very similar to the rate constant value, 3.2×10^4 M^{-1} sec^{-1}, found for the vanadate dimerization, which hints that both reactions might have the same rate determining step, possibly the removal of a coordinated water molecule. (Dissertation Abstr.)

33310 GAS CHROMATOGRAPHIC STUDY OF URANIUM OXIDATION MECHANISM IN MOIST GASES. Kondo, Tatsuo. Columbus, Ohio, Ohio State Univ., 1965. 114p.

Thesis.

Kinetics of oxidation of uranium in moist gases and its correlation to the morphology of the surface product layers were studied in detail by quantitative gas chromatographic and metallographic techniques. The kinetic behavior of the moisture oxidation was confirmed to involve three different rate stages: (1) $W = k_1 \log (at + 1)$, the direct logarithmic time dependency stage, (2) $W = k_2 t^{1.5} + C_1$, the time-powered dependency stage, and (3) $W = K_3 t + C_2$, the linear stage. These processes occur in the order given. By separating each elementary process the empirical activation energy was shown to consist of two components, indicating that the overall corrosion is a process of mixed control with two different controlling steps in operation. In the test temperature up to 90°C, corrosion of unalloyed uranium involves both a hydride formation reaction and a hydride → oxide transformation reaction. The former takes place at the metal-hydride interface, while the latter takes place at the oxide-hydride interface and is controlled by oxygen diffusion through the nonstoichiometric oxide, UO_{2+x}. The mode of mutual dependency of the two processes is such that the diffusion-controlled oxide growth on the surface of hydride was repeatedly activated by the growth-induced fracturing of the underlying hydride, while the oxidation of hydride by water supplies active hydrogen to feed the hydride-forming reaction. The mechanism of oxygen's inhibitive action to the corrosion was experimentally demonstrated. The characteristics of the kinetics can be explained only by the above mechanism. Other experimental results involving specimen temperature measurements, material balance after reaction, and metallographic observation were consistent with the proposed mechanism. (Dissertation Abstr.)

33311 COMPLEX COMPOUNDS OF URANIUM. Chernyaev, I. I. (ed.). New York, Daniel Davey and Co., Inc., 1966. 531p. $21.50. (IPST-Cat.-2173). Jerusalem, Israel Program for Scientific Translations, 1966.

Translated from Kompleksnye Soedineniya Urana by L. Mandel.

The specific properties of uranium as a complex-former are considered. The compounds of hexa- and tetra-valent uranium are described. Results of geometrical analyses of many compounds are reported. A description is given of the known structures and electron distribution of the uranyl group. The complex-forming reactions in the main operations of modern uranium technology are also discussed. The preparation of both already known and freshly prepared complexes is described. (D.H.M.)

33312 MASSIVE CRYSTALS OF U_3O_8. Rhodes, Donald E. (to Kerr-McGee Oil Industries, Inc.). Canadian Patent 732,118. Apr. 12, 1966.

Highly rigid crystals of U_3O_8 thirty microns or larger in aluminum cermets retain a major portion of the fission gases and allow a burnup approaching 20,000 MWd/ton. Uranium dioxide (UO_2) is heated rapidly to 950 to 1150°C and held in this temperature range for about 5 hr in an atmosphere of air or oxygen. Massive crystals of U_3O_8 result when the melt is cooled in air. (F.S.A.)

33313 DISSOLUTION OF PLUTONIUM. Hopkins, Horace H. Jr.; Kingsley, Richard S.; Conner, Eben L. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,259,473. July 5, 1966.

A process is described for dissolving plutonium. The plutonium is immersed in aqueous nitric acid at 1 and 5M, containing hydrazine in a concentration between 0.1 and 2M and hydrofluoric acid in a concentration between 0.0001 and 0.01M. The metal-acid system is heated to a temperature between 50 and 100°C. (AEC)

33314 SINGLE-STEP PROCESS FOR PREPARATION OF URANIUM DIOXIDE FROM URANIUM HEXAFLUORIDE. Heestand, R. L.; Leitten, C. F. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,260,575. July 12, 1966.

A single-step process is described for preparing uranium dioxide from uranium hexafluoride by contacting UF_6 with a stoichiometric excess of a gaseous mixture of hydrogen and an oxygen-bearing gas selected from the group consisting of gaseous oxygen and water vapor at a temperature above 1100°C and a pressure not exceeding 20 torr. (AEC)

33315 PRODUCTION OF ZIRCONIUM AND SILICON TETRAHALIDES. Callow, Alan Edward; Harris, Bernard (to British Titan Products Co. Ltd.). British Patent 1,031,371. June 2, 1966. Filed Jan. 24, 1962.

A process for the production of zirconium and silicon tetrahalides comprises halogenating a zirconia-silica ore in a fluidized bed in the presence of a reducing agent and a potassium halide and recovering the tetrahalides from the reaction gases. Any halogen except fluorine is suitable for use in the process. The process is particularly applicable to zirconia, and the preferred reducing agent is C. (B.L.M.)

33316 PRODUCTION AND RECOVERY OF BERYLLIUM CHLORIDE. Bach, Ricardo O. (to Beryllium Metals and Chemicals Corp.). U. S. Patent 3,250,592. May 10, 1966. Filed Apr. 16, 1964.

A process for producing the chloride of Be from an oxidic Be ore comprises the steps of sintering a mixture of particulate Be ore with elemental or alloyed Si in a ratio ranging from 1:2 to 1:6, reacting the mixture with chlorine at a temperature ranging from 800 to 1600°C, and isolating beryllium chloride from the reaction products in the gaseous state. (B.L.M.)

33317 REDUCTION OF URANIUM HEXAFLUORIDE TO URANIUM TETRAFLUORIDE. O'Donnell, Thomas Aloysius (to Univ. of Melbourne). U. S. Patent 3,251,644. May 17, 1966. Priority date Aug. 17, 1962, Australia.

A process for the reduction of UF_6 to UF_4 comprises evacuating a system to substantially remove the water vapor, reacting the UF_6 with PF_3 in the gaseous phase at a temperature below 150°C to form UF_4 and an intermediate fluoride, and then heating the intermediate fluoride to form UF_4. (B.L.M.)

33318 PLUTONIUM ENRICHED URANIUM FUEL FOR NUCLEAR REACTORS. Michaud, Gaetan G. J.; Hart, Robert G. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,254,030. May 31, 1966. Filed July 27, 1962.

A method is described for producing a fuel for nuclear reactors comprising a mixture containing at least 75 wt % UO_2 and the remainder refractory PuO_2 with at least 80 wt % of the PuO_2 being of a size from 44 to 840 μ and not more than 10% soluble from the mixture in concentrated HNO_3 in 3 hours at 60°C. The fuel has a density of 90 to 95% of theoretical density. One of the group of Pu com-

pounds consisting of Pu oxalate, Pu nitrate, and Pu hydroxide is ignited to form PuO_2 which is then pyrolyzed at a temperature of at least 800°C to form refractory particles of PuO_2 of the proper size and density. The refractory particles of PuO_2 are mixed with UO_2 in the proper proportions by weight, compacted, and sintered to yield a mixture of the desired density and characteristics. (B.L.M.)

33319 THERMODYNAMIC INVESTIGATION OF RARE EARTH OXYCHLORIDES. Baev, A. K.; Novikov, G. I. (Leningrad State Univ.). Zh. Neorg. Khim., 10: 2457-64 (1965). (In Russian).

A thermographic study of the $LaCl_3-La_2O_3$ and $NdCl_3-Nd_2O_3$ systems showed that the oxychlorides were formed, and that LaOCL decomposed at 934°C and NdOCl decomposed at 791°C. The reaction 2 $MeCl_3$ (solid) + O_2 (gas) → 2MeOCl (solid) + 2Cl_2 (gas) was followed manometrically for the lanthanum compound, and values of ΔH_T^0 and ΔS_T^0 were found to be 18.2 kcal/mol and 20.1 e.u. respectively. The enthalpies of formation of the rare earth oxychlorides were calculated from the reaction $MeCl_3$ (solid) + H_2O (vapor) → MeOCl (solid) + 2HCl (vapor) by use of values of the heat of formation of the rare earth oxides and chlorides, of HCl, and of H_2O taken from standard tables. The ΔH^0 values for the formation of $MeCl_3$, MeOCl, and Me_2O_3 were tabulated for the various rare earth elements. The stabilities of the various rare earth oxychlorides could be estimated from these data. (TTT)

Organic Chemistry

Refer also to abstracts 32905, 32935, 33061, and 34990.

33320 (BNL-940, pp 57-68) ON THE THEORY OF COILING AND UNCOILING OF DNA MOLECULES. Montroll, Elliott W. (Institute for Defense Analyses, Washington, D. C.).

The structure of the DNA molecule is considered, and various models for the thermal splitting and uncoiling of this molecule are discussed. These include the random model, the model with nearest-neighbor correlations, the first form of the partition function for a mixed system, and regularly spaced type 2 bonds. (J.F.P.)

33321 (CONF-660320-3) ISOTOPE EXCHANGE RATES. V. MECHANISM OF THE HOMOGENEOUS REACTION BETWEEN C_2H_2 AND C_2D_2. Jeffers, Peter; Bauer, S. H. (Cornell Univ., Ithaca, N. Y. Dept. of Chemistry). [1965]. Contract AT(30-1)-2139. 24p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Chemical Society, 151st Meeting, Pittsburgh.

The rate of isotopic exchange between acetylene and dideuteroacetylene was measured using a single pulse shock tube. The temperature range covered was 1150 to 1450°K, with C_2H_2/C_2D_2/argon mixtures 4.5/0.5/95; 4/1/95; 3/2/95; 2/3/95; 1/4/95; 2/2/96; and 1/1/98. Reflected shock total densities were (0.8 to 3.0) × 10^{-2} moles/l. The data may be represented by an empirical power rate expression: $[\Delta(C_2HD)/\tau] = k_f(C_2H_2)^{0.25}(C_2D_2)^{0.5}(Ar)^{0.5}$, where $k_p = 1.41 \times 10^8 \exp(-35{,}800/RT)$ (moles/l)$^{-0.25}$ sec^{-1}. The mechanism that best accounts for these observations includes vibrational excitation of acetylene and subsequent formation of molecular dimers. Hydrogen exchange occurs through rearrangement during the dimer stage, followed by destruction. Free radical processes were found to be incompatible with these observations. (auth)

33322 (IS-1215) ISOTOPE EFFECTS ON MOLAR VOLUME AND SURFACE TENSION: SIMPLE THEORETICAL MODEL AND EXPERIMENTAL DATA FOR HYDROCARBONS. Bartell, L. S.; Roskos, R. R. (Ames Lab., Iowa State Univ. of Science and Tech.). Apr. 9, 1965. Contract W-7405-eng-45. 25p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Experimental measurements of molar volumes and surface tensions of benzene, toluene, cyclohexane, and methylcyclohexane, and of their completely deuterated analogs are presented. The lighter species have a greater volume by about 0.3%. Surface tensions of the lighter species are greater; also, and increase from 0.2% to 1% as the number of hydrogens per carbon increases. Results are interpreted on the basis of the bond stretching anharmonicity, which makes C−H bonds longer and more polarizable than C−D bonds. The "steric" and polarizability effects are comparable in magnitude but opposite in sign in their influence on cohesive properties. It is shown by a simple theoretical model that the "pure mass effect" on molar volume arising from zero-point translational motions of the molecules as a whole is negligible in comparison with the effects stemming from zero-point motions of the C−H and C−D bonds. (auth)

33323 STUDIES ON HYDROGEN-ABSTRACTING REACTIONS. I. DEUTERATION OF PYRIDINES AND PYRIDAZINES. Kawazoe, Yutaka; Ohnishi, Masako; Yoshioka, Yuko (National Cancer Center Research Inst., Tokyo). Chem. Pharm. Bull. (Tokyo), 12: 1384-6(Nov. 1964).

A convenient preparative method of deuteropyridines and deuteropyridazines was developed using their N-oxidized derivatives as the starting material, followed by reduction of the N-oxide group. Deuterium displacement reactions for preparation of deuterated pyridines are summarized. Deuteration occurred only in alkaline medium (the more concentrated the alkali, the faster the reaction rate). The quaternary salt reacted faster than the N-oxide, followed by pyridine itself; thus deuterium displacement in this case should be considered as a proton exchange reaction of ring hydrogens activated by the $N-O^-$ group. Pyridazine N-oxide underwent stepwise deuterations at 6,5 and then at the 4 and 3 positions. The 6 position (α to the N-oxide group) was activated and reacted readily even at room temperature. It was noted that the 4 and 5 hydrogens, more distant from the ring nitrogen, were more easily deuterated in alkaline medium than 3 and 6 in α position to the nitrogen. (TCO)

33324 DEUTERIUM AND THE OCTANT RULE. Meyer, Walter L.; Lobo, Angelo P. (Indiana Univ., Bloomington). J. Amer. Chem. Soc., 88: 3181-2(July 5, 1966).

D-(+)-Isoketopinic acid was prepared from D-(+)-camphor by α bromination, π bromination, α debromination, displacement of the π bromine by acetate, saponification, and oxidation. The molecular amplitudes of the Cotton effects of the starting camphor and product camphor are identical, showing that optical purity is retained throughout the synthetic sequence. The 9-methyl group of camphor lies in a positive octant, but the atomic refractivity of deuterium is less than that of hydrogen (the polarizability of a C−D bond is less than that of a C−H bond). Thus deuterium produces a contribution to the Cotton effect of sign opposite that predicted by the general octant rule. Results suggest deuterium is a normal substituent as far as the octant rule, so long as its atomic refractivity properties are not overlooked. (P.C.S.)

33325 DEUTERIUM NUCLEAR QUADRUPOLE INTERACTION IN FC ≡ CD, $CH_3C \equiv CD$, AND ClC ≡ CD. Weiss, V. W.; Flygare, W. H. (Univ. of Illinois, Urbana). J. Chem. Phys., 45: 8-10(July 1, 1966).

The deuterium nuclear quadrupole coupling constants of $CH_3-C \equiv C-D$, $Cl-C \equiv C-D$, and $F-C \equiv C-D$ were determined in order to investigate the effect of substitution on the electron distribution in the C−D bond. The results along the C−D bond yield $\chi_D = 208 \pm$ kc/sec for $CH_3-C \equiv C-D$, $\chi_D = 212 \pm 10$ kc/sec for $F-C \equiv C-D$, and $\chi_D = 225 \pm 18$ kc/sec for $Cl-C \equiv C-D$. The results show equal deuteron field gradients within experimental error and therefore show that the C−D bond is relatively insensitive to the substitution at the other end of the acetylenic bond. (auth)

33326 LABELING OF ASPARTIC ACID BY HOT TRITIUM ATOMS. Kolomiitsev, M. A.; Gamkrelidze, Ts. D. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 42: 311-14(May 1966). (In Russian).

Aspartic acid was labeled with tritium recoil atoms from the reaction $^6Li(n,\alpha)^3T$ by irradiating 1.0 g of aspartic acid and 100 mg of $LiCO_3$ at a neutron flux of 10^{12} neutrons/cm^2-sec. The labeled aspartic acid was isolated in the form of its barium salt in order to determine the specific activity. At first the specific activity increased almost linearly with irradiation time, but fell off at the higher integrated neutron and gamma irradiation dose. The specific activity also increased by a factor of 5 on increasing the ratio of amino acid to lithium carbonate to 1:2. A short irradiation time of 2 to 4 hours was optimum for labeling aspartic acid. (TTT)

Radiation Chemistry

See also BIOLOGY AND MEDICINE — Radiation Effects on Biochemicals Radiation Effects on Tissues

33327 (AD-634912) ^{60}Co RADIOLYSIS OF SOLID ETHYL IODIDE. Hermann, G. L.; Harrah, L. A. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). Sept. 17, 1965. 29p. (AFML-TR-65-333). CFSTI $2.00 cy, $0.50 mn.

Glass and polycrystalline ethyl iodide at 77°K were irradiated with ^{60}Co. Yields of free radicals were measured with an electron paramagnetic resonance spectrometer. G values for radicals in glass and polycrystalline phases were 1.53 and 0.33. Hydrocarbon reaction products were separated by Toepler pumping and measured with a mass spectrometer. Products containing I were measured by spectrophotometric methods. Ethene-ethane and HI-I product ratios were much higher in the polycrystalline phase than in the glass phase, and higher in the glass phase than in previous results from the liquid phase. (auth)

33328 (BNL-9376) HOT-ATOM REACTION PRODUCTS IN CRYSTALS OF HEXA- AND TRIVALENT CHROMIUM COMPOUNDS. Guetlich, Philipp; Harbottle, Garman (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 31p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The distribution of ^{51}Cr recoil atoms among the various possible chemical forms in neutron-irradiated chromium compounds was reexamined. Chromous ions are not found in potassium chromate. However in both potassium and ammonium chromates a large proportion of the reduced fraction is found in the form of a dimer. In irradiated (hydrated) chromic salts, substantial percentages of labeled chromous ions are found, as well as the dimer. The results are interpreted in terms of possible recoil mechanisms. (auth)

33329 (BNL-9408) REACTIONS OF ENERGETIC CARBON ATOMS IN METHYLAMINE. Cacace, Fulvio; Stoecklin, Gerhard; Wolf, Alfred P. (Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT(30-2)-Gen-16. 22p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The reactions of recoiling carbon atoms produced via the $^{14}N(p,\alpha)^{11}C$ process were studied in gaseous and liquid methylamine, with and without scavenger. The product-forming mechanisms in this system seemed to follow the general pattern of the chemistry of energetic carbon atoms in simple hydrocarbons. The major products resulting from fragmentation of excited intermediates were acetylene and ethylene. Ethylamine and dimethylamine were found as the expected synthesis products. A small yield of acetonitrile, which remained uneffected by the presence of scavenger or the change of phase, was also found. In agreement with the deexcitation-fragmentation hypothesis the yield of the fragmentation products, acetylene and ethylene, decreased while the yield of the synthesis products, ethylamine and dimethylamine, increased in the condensed phases. The formation of the products is explained on the basis of insertion reactions. From comparison of the acetylene and ethylene yields in methylamine with those in the ethane system it seemed that C-H bonds are much more reactive towards insertion reactions than N-H bonds. Whether this is due to a lower reaction probability or to a more easily stabilized intermediate could not be decided on the basis of the present evidence. Comparison with alkane systems showed no effect of the "leaving group" on the postulated acetylene and ethylene producing fragmentation process. It is suggested that the formation of acetonitrile takes place via decomposition of an excited ethyleneimine molecule, since the activity is equally distributed between the two carbon atoms. (auth)

33330 (BNL-9431) OPTIMIZATION OF A RADIATION CHEMICAL REACTOR FOR THE POLYMERIZATION OF ETHYLENE. Kukacka, Lawrence E.; Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Aug. 1965. Contract AT(30-2)-Gen-16. 32p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The optimization of a radiation chemical reactor for the polymerization of ethylene was made by combining the radiation physics and the chemical kinetics of the system. A general method developed for an internal array of sources in a cylindrical geometry was used to determine the radiation distribution and utilization efficiency in the vessel. Experimentally determined expressions for the rate of polymerization were used for the kinetics of the reaction. The optimum design, as a function of operating pressure, radiation intensity, and vessel dimensions, was determined. Limitations of the design due to thermal and mass transfer effects are discussed. (auth)

33331 (BNWL-SA-712) FORMATION OF LONG-LIVED ORGANIC RADICALS IN IRRADIATED AQUEOUS SOLUTION. Kalkwarf, D. R.; Diebel, R. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 26, 1966. Contract AT(45-1)-1830. 9p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A study was conducted to determine the chemical structure and reactivities of organic, free-radical intermediates and their role in radiobiological damage. It was found that radioinduced organic radicals are stable for minutes to days in aqueous solution. Similar radicals are thought to exist also in irradiated biological systems; further investigations are suggested. (J.R.D.)

33332 (EGG-1183-2099) THE EFFECTS OF OXYGEN QUENCHING ON THE TIME RESPONSE OF LIQUID ORGANIC SCINTILLATORS. Yates, E. C.; Crandall, D. G.; Kirkbride, J. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). June 1966. Contract AT(29-1)-1183. 17p. (CONF-660612-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Symposium on Organic Scintillators, Argonne, Ill. For Univ. of California Lawrence Radiation Lab., Livermore.

Research directed toward development of faster organic scintillators, with shorter decay times, and minimized long-tail light output (quenching) is reported. Quenchers examined include oxygen, acetophenone, bromobenzene, cyclohexanone, acetic acid, and acetone. (J.R.D.)

33333 (N-66-13092) INVESTIGATION OF EXPLOSIONS IN IRRADIATED LIQUID-NITROGEN DEWARS. Romanko, J. (General Dynamics/Fort Worth, Tex.). Dec. 15, 1964. Contract AF29(601)-6213. 122p. (NASA-CR-68435; FZK-219). CFSTI $4.00 cy, $1.00 mn.

Investigations were conducted on the phenomena occurring before, during, and after explosions involving irradiated dewars of liquid nitrogen and various amounts of impurities, including oxygen, water vapor from the ambient air, and solid catalysts, to determine the cause of explosions in cryogenic test vessels used in nuclear reactor experiments. The first part of the study involved producing explosions under controlled conditions in specially designed open and closed dewars outfitted with various diagnostic instruments, and identifying the conditions under which the explosions occur. However, this study was terminated before sufficient data could be obtained. The second part involved fundamental experiments using spectrometric instruments to determine the processes leading to explo-

sions. Spectrographic studies were conducted using a common dewar to obtain information on reactions occurring during the explosions. Electron paramagnetic resonance experiments were conducted on samples of irradiated impure liquid nitrogen subsequently investigated for paramagnetic species as a function of irradiation dose, to determine reactions occurring before explosions. (STAR)

33334 (NYO–3242-13) SENSITIZED RADIOLYTIC ISOMERIZATION OF STILBENE. Fischer, Ernst; Lehmann, H. P. (Weizmann Inst. of Science, Rehovoth (Israel). Photochemical Lab.); Stein, Gabriel (Hebrew Univ., Jerusalem (Israel). Dept. of Physical Chemistry). [1965]. Contract AT(30-1)-3242. 7p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The effects of gamma radiation and x radiation on cis-stilbene and trans-stilbene in benzene were investigated. The isomeric compositions of irradiated samples were analyzed spectrophotometrically. Data are also included on the effects of air, anthracene, naphthalene, and biacetyl on the radioinduced reactions. (J.R.D.)

33335 (ORO–2945-4) PREPARATION OF WOOD-PLASTIC COMBINATIONS USING GAMMA RADIATION TO INDUCE POLYMERIZATION. Topical Report on IMPREGNATION OF WOOD WITH ACRYLIC MONOMERS. Kent, James A.; Loos, Wesley E.; Walters, William R.; Boyle, William R.; Taylor, George W.; Winston, Anthony W. (West Virginia Univ., Morgantown. Engineering Experiment Station). Apr. 1, 1966. Contract AT(40-1)-2945. 61p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work directed toward development of wood treating cycles to produce maximum monomer loadings and to develop cycles to produce uniform partial monomer loadings is discussed. White pine boards were used in the experiments, and treatments were conducted using methyl methacrylate inhibited with butylated hydroxytoluene. A pressure cycle was found best for high loadings, and allowance of one to three days for capillary redistribution appears to be most effective for partial loadings. (J.R.D.)

33336 (PRNC–86) HOT-ATOM CHEMISTRY PROGRAM. Progress Summary Report No. 1, July 1964–May 1966. (Puerto Rico Nuclear Center, Mayaguez). Contract AT(40-1)-1833. 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Activities in a program to study hot-atom reactions in organic compounds with multiple covalent bonds between carbon and activated atoms are reported. Nuclear reactions of the n, gamma type were employed. Results are included from studies of organic P, S, and Hg compounds. (J.R.D.)

33337 (RISO–114) POLAROGRAPHIC STUDY OF OXYGENATED AQUEOUS SOLUTIONS IRRADIATED WITH 10 Mev ELECTRON PULSES. Zagorski, Z. P.; Sehested, K. (Danish Atomic Energy Commission, Risoe. Research Establishment). Sept. 1965. 41p. Dep. mn.

In continuation of a polarographic study of gamma-irradiated solutions, the methodics of measurements of intermediate and stable products were developed for pulsed electron irradiation (Risö electron linear accelerator, 10 Mev, 7 μsec, 0.2 A). In a proper experimental arrangement, only a small "electron peak" appears, which does not disturb the measurement of phenomena after the pulse. Different indicating electrodes were employed: a microplatinum electrode, a very slow dropping-mercury electrode, and the conventional dropping-mercury electrode with the dropping time adjusted mechanically at 1 sec. The current measurements were performed with the polarograph at constant potentials applied in different parts of the polarographic spectrum, thus providing kinetic curves for different constituents of the solution. Some oscillopolarographic curves were also taken. As a model system, one with pH-values in the range from 1 to 13 ClO_4^- (or SO_4^{--}) and saturated with oxygen (1 atm) was investigated. In the pH range 1 to 4.8 an intermediate was found (of which 99% was decayed after 6 seconds) and the compound was reduced cathodically in the total range of potentials available. It was found that the intermediate decomposed not only into O_2, but also into H_2O_2. The composition of the intermediate was concluded to be H_2O_4. The formation reaction would then be $2\ HO_2 \rightarrow H_2O_4$. Additional amounts of H_2O_2 observed are explained by direct combination of OH radicals. The findings do not exclude concurrent production of H_2O_3. (auth)

33338 (RRL–2310-180) IDENTIFICATION OF RADICALS AND MEASUREMENTS OF THEIR YIELDS BY ESR AND SCAVENGER METHODS. Schuler, Robert H.; Fessenden, Richard W. (Radiation Research Labs., Mellon Inst., Pittsburgh, Pa.). June 14, 1966. Contract AT(30-1)-2310. 26p. (CONF-660614–1). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From 3rd International Congress on Radiation Research, Cortina, Italy.

Examination of the electron spin resonance spectra of liquid hydrocarbons during irradiation with Mev electron beams provides identification of the predominant radical species present. It is shown that in some cases these radicals are produced in primary chemical processes and in other cases as a result of secondary reactions of hydrogen atoms with olefins and other reactive solutes. Spin resonance experiments also allow direct measurement of radical lifetimes and concentrations and as a result permit the determination of yields on a chemically unperturbed system by purely physical methods. In general these studies confirmed the identification and yield measurements of intermediary radicals inferred from other studies, which employ iodine, tritium iodide, or labelled methyl or ethyl radicals as scavengers. It is clear that, in any complete discussion of the radiolysis of aliphatic hydrocarbons, account must be taken of the production of radicals with a G in the range of 4 to 6. (auth)

33339 (JPRS–35342, pp 8-18) MUTUAL INFLUENCE BETWEEN THE EFFECTS OF RADIATION AND THE CRYSTALLIZATION PROPERTIES OF POLYETHYLENE. Hsiao, Chou; Chih-p'ing, Chang. Translated from Ko Fen Tzu T'ung Hsun, 7: 386-95(1965).

The effects of γ radiation on the crystallization properties of polyethylene and on polyethylene single crystals were studied. It was found that, under the same conditions of crystallization, the morphology of the crystals changes regularly as the dose increases. Gamma radiation produced wrinkles in polyethylene single crystals but there was no correspondence between the number of wrinkles and the radiation dose. It was concluded that a perfect crystal lattice has better resistance to γ radiation. (M.C.G.)

33340 ACTION OF γ RADIATION ON AQUEOUS SOLUTIONS OF POTASSIUM AND IRON THIOCYANATE. Duflo-Plissonnier, Marcelle (Institut du Radium, Paris). Ann. Chim. (Paris), 10: 551-82(Nov.-Dec. 1965). (In French).

Thiocyanate solutions were irradiated with 100- and 3000-C ^{60}Co sources. Radiolysis of thiocyanate ion, with exclusive breakage of the S–C bond occurred during irradiation of pH values between 0.4 and 13.5. In the presence of air, cyanide and sulfate ions were formed. Variations in the amount of the products at different pH values could be attributed to the different actions of the radicals that were formed from radiolysis of water, namely HO_2 and O_2^-. The O_2^- radical gave different effects in neutral and alkaline media. In neutral solution it gave H_2O_2 and at alkaline pH it had an oxidizing effect similar to that of HO_2. In the absence of air in neutral solution radiolysis of SCN ion was much less than in the presence of air. In alkaline solution, sulfite and traces of sulfide, but no sulfate, were obtained; whereas hydrogen sulfide predominated in acid solutions. Maximum radiolysis of SCN ion occurred at pH 4.2. It was concluded that the primary oxidation of SCN^- occurs rapidly with OH radicals; the other radiolytic products can then be accounted for by reactions of the intermediate product with e^-, O_2^-, HO_2, and H_2O_2. (BBB)

33341 INVESTIGATION OF THE CHEMICAL FORM OF RADIOACTIVE PHOSPHORUS PRODUCED BY NEU-

TRON IRRADIATION OF SULFATE. Moro, Antonio Lo; Frediani, Sergio (Univ., Pisa, Italy). Ann. Chim. (Rome), 56: 339-47(1966). (In Italian).

Aqueous solutions of Na_2SO_4, K_2SO_4, $MgSO_4$, $NiSO_4$, $Al_2(SO_4)_3$, $(NH_4)_2SO_4$, and $K_2S_2O_8$ were neutron irradiated and products of the $^{32}S(n,p)^{32}P$ reaction and, in particular, radiophosphorus oxidation states were examined. The analytical method consisted of gradient elution anion-exchange chromatography, which made it possible to elute, successively, hypophosphites, phosphites, and phosphates. After adsorption on cationic resin, the samples were passed through an anionic column (Dowex 2) which had been washed with KCl (0.05M buffered at pH 11 with NH_3). Elution was started with 0.05M KCl (pH 11) in the mixing vessel and with 0.4M KCl (pH 11) in the reservoir. The collected fractions were counted with a β scintillation well detector and the phosphorus content of each fraction was determined by spectrophotometry of phosphovanadomolybdate complex. It was found that radiophosphorus was present in the irradiated solutions exclusively as phosphate. The same state of phosphorus oxidation is found when the dry sulfate salts are neutron irradiated. (TCO)

33342 DIFFERENCES IN ANTHRACENE OIL RADIOLYSIS BY γ RADIATION AND BY FAST NEUTRONS. Proksch, E. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). Atomkernenergie, 11: 326-32(July-Aug. 1966). (In German).

Measurements in a reflector position of the ASTRA have been used in combination with earlier measurements in the center of the ASTRA core to extrapolate the radiolytic decomposition of VOEST Anthracene Oil 1 by pure γ radiation and fast neutrons, respectively. The G_γ^0 values are independent of temperature: $G_\gamma^0(\rightarrow HBR) = 0.22 \pm 0.04$, $G_n^0(gas) = 0.016 \pm 0.010 \cdot G_n^0(\rightarrow HBR)/G_\gamma^0(\rightarrow HBR)$ increases from 2.6 ± 0.5 at 200 to 275°C to 5.1 ± 1.0 at 380°C, $G_n^0(gas)/G_\gamma^0(gas)$ increases from 7 ± 4 at 200°C to 20 ± 12 at 380°C. Parallel measurements using a terphenyl mixture for comparison yielded a $G_\gamma^0(\rightarrow HBR)$ of about 0.15 and a $G_n^0(\rightarrow HBR)$ of about 0.30, both independent from temperature in the range of 275 to 350°C. Radiolytic tar (HBR, high boiling residues) from Anthracene Oil 1 has been found to decompose back to anthracene oil when pyrolyzed at temperatures higher than the temperature during radiolysis. (auth)

33343 EFFECTS OF GAMMA RADIATION ON POLYMER IN SOLUTION. IX. A TURBIDIMETRIC STUDY ON SOLUTION OF POLY(VINYL ALCOHOL) IRRADIATED BELOW CRITICAL CONCENTRATION FOR GEL-FORMATION. **Sakurada, Ichiro; Ikada, Yoshito (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 44: 66-73(Jan. 1966).**

The radius of micro-gel particles formed on irradiation of dilute aqueous solution of PVA was estimated by turbidity measurement and supplemented by electron micrographs. The radius calculated from the turbidity was in the range of 500 to 2400 Å depending on radiation dose, polymer concentration at irradiation, and degree of polymerization of sample. It was found that the dimension of micro-gel particle became smaller as irradiation proceeded. This fact suggests strongly that intramolecular cross-linking occurs with irradiation. The particle sizes calculated from the turbidity were 5 ~ 8 times larger than those determined by the electron micrograph. It was concluded that from the turbidimetric method the radius of micro-gel particle was determined, whereas from the electron micrograph only the radius of the small particle, which forms the microgel particle can be measured. (auth)

33344 EFFECT OF γ RAYS ON PYRIMIDINE BASES IN AQUEOUS SOLUTION. II. THYMINE. Nofre, Claude; Cier, Andre (Centre de Recherches du Service de Sante des Armees, Lyon). Bull. Soc. Chim. France, No. 4, 1326-33(Apr. 1966). (In French).

Thymine irradiated in aqueous solutions by γ rays gives different products of which a certain number can be identified quantitatively. The proper role of each of the chemical species from the radiolysis of the water was assigned; the stereochemical aspects of the actions were discussed. (tr-auth)

33345 PRODUCTS OF GAMMA IRRADIATION OF MALEIC ANHYDRIDE IN BENZENE. Raciszewski, Zbigniew (Union Carbide Corp., South Charleston, W. Va.). Chem. Ind. (London), No. 10, 418-19(Mar. 5, 1966).

A degassed solution containing 4.1% of maleic anhydride was irradiated for 231 hr in a ^{60}Co source with a dose rate of 0.108 Mrad/hr yielding a crude polyanhydride in the amount equal to 21% of the weight of charged maleic anhydride. About three quarters of the polyanhydride precipitated from the solution; the remaining quarter was isolated by evaporation of the solvent and removal of the unreacted maleic anhydride by sublimation. The precipitated portion was treated with methanol, methylated with diazomethane, and separated by chromatography on silica to give a polyester and the tetramethyl ester of the maleic anhydride–benzene. The yield of ester, based on charged maleic anhydride, was 0.8% and G was 0.07. It is suggested that formation of the adduct followed the same path both in the γ- and previously reported uv-induced reactions; the path involved electronic excitation of the precursor of maleic anhydride or its charge transfer complex with benzene. (TCO)

33346 RADIATION CHEMISTRY OF SYNTHETIC MACROMOLECULES IN SOLUTION, LET EFFECTS. **Henglein, A.; Schnabel, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). pp 1-67 of Current Topics in Radiation Research. Vol. II. Ebert, Michael; Howard, Alma (eds). Amsterdam, North-Holland Publishing Company, 1966.**

Fundamentals of polymer chemistry and radiation chemical reactions of macromolecules in the solid state are briefly reviewed. These are then used in describing reactions that occur in solutions of polymers under the influence of radiations of low LET. A theoretical examination of the problem is followed by descriptions of the behavior of macromolecules in aqueous and non-aqueous solutions. A comparison of the effects produced by low and high LET radiations on polymers and some theoretical considerations are also given. (86 references). (P.C.H.)

33347 ENERGY TRANSPORT IN CARBOHYDRATES. **Phillips, Glyn O. (Univ. Coll., Cardiff, Wales). pp 129-93 of Current Topics in Radiation Research. Vol. II. Ebert, Michael; Howard, Alma (eds.). Amsterdam, North-Holland Publishing Company, 1966.**

Recent information on the energy transfer properties of carbohydrates as indicated by the chemical effects of gamma radiation on the solid state is summarized. Experimental demonstrations and possible mechanisms of electronic energy transfer are also considered. The topics covered include: transfers of energy from high energy radiations; experimental evidence for electronic energy transfer; mechanisms of energy transfer; excitation energy transfer in radiation chemistry; energy transport in D-glucose crystals; energy transfer in cycloamylose complexes; and intramolecular energy transfer. (199 references). (P.C.H.)

33348 ADDITION OF MOLECULAR NITROGEN TO PERCHLOROHYDROCARBONS UNDER INFLUENCE OF IONIZING RADIATION. **Vereshchinskii, I. V.; Podkhalyuzin, A. T. (Karpov Inst. of Physics and Chemistry, USSR). Dokl. Akad. Nauk SSSR, 165: 107-9(Nov. 1, 1965). (In Russian).**

Gamma irradiation (^{60}Co) of tetrachloroethylene solutions of nitrogen at a rate of 280 rads/sec resulted in combination of the nitrogen with the solvent. For liquid solutions the amount of nitrogen combined, as determined by the Kjeldahl method, was directly proportional to the absorbed dose in the range studied (up to 100 Mrads) and increased with increasing pressure (1.5 to 120 atm) and temperature (41 to 250°C). The maximum combined was 1 mg/ml for runs at 167°C and 50 atm and at 41°C and 120 atm. Irradiation of the solid (77°K and 120 atm) resulted in the amount combined rising to about 0.4 mg/ml at 10 Mrads but then gradually falling to less than 0.2 mg/ml at about 110 Mrads. The absorption spectra of the product solutions showed the characteristic peak at 290 to 292 mμ. The optical density

at this wavelength increased from about 0.05 to 0.3 with increasing dose from 0.01 to 0.1 Mrad. The activation energy of the process was calculated to be 1.5 kcal. The structure of the addition product is suggested to be a diazo cyclic type. (TTT)

33349 EFFECTS OF γ-RAY IRRADIATION ON ELECTRIC PROPERTIES OF POLYSTYRENE. Nakai, T.; Sakakibara, T. (Inst. of Physical and Chemical Research, Tokyo). Electrotech. J. Jap., 8: 163-9(1963).

The action of ^{60}Co γ radiation on polystyrene films and capacitors, which consisted of two sheets of polystyrene film and tin foil rolled up and heated above the softening temperature of polystyrene, was studied. Marked changes on the appearance of the specimens were observed despite the negligibly small change in resistivity. The specimens irradiated in air were light yellow after exposure to more than 10^8 R and became so fragile after 2.9×10^8 R that they were easily cracked when stretched for measurement. Infrared spectrum, viscosity, and elastic modulus of irradiated material were measured. Carbonyl groups were found in specimens irradiated at 2.9×10^8 R in air, but not in those irradiated in vacuo. Average molecular weight estimated to be 320,000 in unirradiated specimens decreased to 90,000 after exposure to 2.9×10^8 R. The specimens irradiated in vacuo showed an increase of intrinsic viscosity, and cross-linking could be recognized by the occurrence of gelation at 6.1×10^7 R and of the insolubility of specimens in solvents after 9.6×10^7 R. Polystyrene films revealed little change in dielectric constant or volume resistivity, but a slight increase in dielectric loss tangent was seen after irradiation in air. A marked decrease in breakdown strength in oil after exposure above 10^8 R was seen in specimens irradiated in air. (BBB)

33350 EFFECT OF IONIZING RADIATIONS ON ANTIOXIDANTS IN FATS. Chipault, J. R.; Mizuno, G. R. (Univ. of Minnesota, Austin). J. Agr. Food Chem., 14: 221-4(May-June 1966).

The effects of ionizing radiation on several antioxidants added to fats prior to irradiation to prevent or minimize loss of stability and dissolved in methyl myristate or methyl linoleate were studied. When used at a concentration of 0.01% in methyl myristate and irradiated under vacuum, 27% of butylated hydroxyanisole, 50% of propyl gallate, and all of the tocopherol were destroyed with a dose of 5 Mrad. In oxygen the same dose almost completely destroyed all antioxidants. Citric acid did not protect propyl gallate from destruction. Destruction was greater in methyl myristate than in methyl linoleate. No further changes occurred during storage of vacuum-irradiated samples. In general, the antioxidant concentration in the samples irradiated and stored under oxygen continued to decrease during storage. This further destruction of antioxidant is probably due to the continued autoxidation of these samples during storage. The G value for the destruction of propyl galate in methyl linoleate during irradiation in vacuum was low (0.07 to 0.13), but in spite of the high concentration of antioxidant, the G value was still 15 to 25 times greater than what would be expected on the chance ionization of the antioxidant molecules during irradiation. This indicates also that the antioxidant is destroyed mostly by secondary reactions, although the effect appears to be less than with methyl myristate. This suggests that the linoleate free radicals are destroyed more rapidly through recombination and polymerization than through reaction with antioxidant molecules. (BBB)

33351 EFFECT OF IONIZING RADIATIONS ON STABILITY OF FATS. Chipault, J. R.; Mizuno, G. R. (Univ. of Minnesota, Austin). J. Agr. Food Chem., 14: 225-9(May-June 1966).

Irradiation of fats produces free radicals which, in the presence of oxygen, can initiate autoxidation chain reactions, and autoxidation products continue to accumulate rapidly during subsequent storage. The influence of irradiation in the absence of oxygen on the ability of the fat to resist autoxidation when the container is opened and the contents exposed to oxygen was determined. Methyl linoleate, natural fats, piecrust, and ground meat were irradiated at doses of 2 to 8 Mrad in the presence and absence of oxygen. Even when antioxidants were present, irradiation almost completely eliminated the induction period of the fats. Storage under vacuum of fats irradiated in oxygen, however, resulted in some recovery of stability. Irradiation in a vacuum decreased the stability of fats, so that when exposed to oxygen after irradiation they underwent autoxidative deterioration more easily. When fats, proteins, and other food components were in intimate contact, the effect of irradiation on the stability of fats was more complex. With piecrust, ground pork, and ground beef, irradiation resulted in an immediate decrease in stability, partly regained during postirradiation storage. Irradiation of ground beef treated with antioxidants produced an immediate improvement in fat stability, which continued to increase during postirradiation storage. The effect did not occur with ground pork and appears to be associated with the free glyceride fat of beef. (BBB)

33352 MOLECULAR IONS IN RADIATION CHEMISTRY. III. ABSORPTION SPECTRA OF AROMATIC-HYDROCARBON CATIONS AND ANIONS IN ORGANIC GLASSES. Shida, Tadamasa; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Chem. Phys., 44: 4372-7(June 15, 1966).

Aromatic hydrocarbons (ArH) in γ-irradiated glassy butyl chloride at 77°K are efficient traps for migrating positive holes, forming the radical cations of 40 compounds in good yield. No ArH^- ions appeared to form. Photobleaching is very inefficient, or nil. Resonance charge transfer and simple competition for holes by ArH, solvent, and anions are consistent with observation. In glassy methyltetrahydrofuran, ArH gave ArH^- in good yields with very little ArH^+. In 3-methylpentane, both ArH^+ and ArH^- were formed. Addition of propyl chloride enhanced ArH^+ and suppressed ArH^-. Addition of ethanol had the reverse effect. (auth)

33353 KINETICS OF IONIC PROCESSES IN THE RADIOLYSIS OF LIQUIDS. II. PROTON TRANSFER FROM CYCLOHEXANE IONS TO ETHANOL. Buchanan, James W.; Williams, Ffrancon (Univ. of Tennessee, Knoxville). J. Chem. Phys., 44: 4377-84(June 15, 1966).

The extent to which positive ions produced by the radiolysis of cyclohexane undergo proton transfer to a dissolved scavenger before geminate recombination was studied by an isotopic method. Ethanol-d (C_2H_5OD) was used, and the yield of HD is related to the yield of scavengable ions. The yield is strongly dependent on ethanol concentration over most of the range but at high concentration (>1M) a limiting value is reached corresponding to an estimated total yield of 2.6 ion/100 ev. The dependence of the yield on scavenger concentration suggests that the distribution of recombination times for ion pairs lies in the range between 10^{-7} and 3×10^{-11} sec corresponding to initial separation distances between 280 and 19 Å, respectively. A median separation distance of 50 Å is indicated. The results are consistent with the earlier supposition that the electron is trapped as a negative entity with molecular dimensions. Some implications of this model are examined. (auth)

33354 MEASUREMENT OF THE RELATIVE ABUNDANCES AND RECOIL-ENERGY SPECTRA OF FRAGMENT IONS PRODUCED AS THE INITIAL CONSEQUENCES OF X-RAY INTERACTION WITH CH_3I, HI, AND DI. Carlson, Thomas A.; White, R. Milford (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 44: 4510-20(June 15, 1966). (ORNL-P-1992).

Methyl iodide, hydrogen iodide, and deuterium iodide were irradiated with x rays, whose energies are such that the most probable event is the formation of a vacancy in the L shell of iodine. The readjustment to this vacancy, principally by a series of Auger processes, gives rise to extensive ionization and decomposition; and the relative abundances of the fragment ions and their recoil-energy spectra have been measured with a specially designed mass spectrometer. As the result of

the inner-shell vacancy, CH_3I decomposed primarily into hydrogen, carbon, and iodine ions, having, respectively, the average charges of 1+, 2+, and 5+. Very few molecular ions were observed. The recoil energies were quite large with values in some cases above 100 ev. A calculation, based on a simple model for a Coulombic "explosion," is shown to be consistent with the data. In the studies made with HI and DI the recoil spectra of H^+ and D^+ are compared with calculations of the kinetic energies expected from multiple ionization. From this comparison there appears to be evidence that the multiply charged molecular ions separate slightly during the time the Auger processes are taking place. Finally, a brief discussion is given concerning the importance of the initial consequence of x-ray interaction in radiation damage. (auth)

33355 OPTICAL STUDY OF X-RAY IRRADIATION EFFECT ON THE PHASE TRANSITION IN TRIGLYCINE SULFATE AND DIGLYCINE NITRATE. Sato, Yoshiki (Japan Atomic Energy Research Inst., Tokyo). J. Chem. Phys., 45: 275-82(July 1, 1966).

Infrared spectra are measured at various temperatures on ferroelectric triglycine sulfate (Tc = 48°C) and diglycine nitrate (Tc = –67°C) and nonferroelectric diglycine hydrochloride, each of which includes a short hydrogen bond connecting two glycine molecules. Almost all of the spectra of these substances are only slightly changed as the temperature passes through the respective Curie points. In contrast, a band at 575 cm^{-1} in triglycine sulfate is very characteristically changed, and its behavior is strongly influenced by x-ray irradiation. Further, a detailed inspection of the spectra shows that above and below the respective Curie points one of the two glycine molecules is in zwitterion form in diglycine nitrate and not in triglycine sulfate, and that the potential for the proton is of symmetrical single-minimum type in the latter and of asymmetrical double-minimum type in the former. Based on these facts, it is suggested that the origin of the phase transition, in triglycine sulfate, is not attributable to the hydrogen bond but to the remarkable intensity behavior of the 575-cm^{-1} band. On the other hand, in diglycine nitrate it is ascribed to a collective motion leading to the interchanging of the hydrogens between two possible equilibrium positions on the hydrogen bonds. (auth)

33356 GAMMA RADIOLYSIS OF ALKALINE AND NEUTRAL SOLUTIONS. III. FORMATION OF H_2 AND O_2 IN WATER AND PURE SOLUTIONS. Haissinsky, Moise (Laboratoire Curie, Paris). J. Chim. Phys., 63: 705-8 (May 1966). (In French).

By γ irradiation of aqueous solutions of NaOH, KOH, or CsOH at pH near 12, H_2 is formed with the molecular yield $G \simeq 0.45$, and O_2 with $G \simeq 0.22$. In general the yields decrease with increasing pH up to 14 and with decreasing pH down to 6, and are affected by the carbonate concentration of the solution. A mechanism is proposed, which explains the protection of H_2 against oxidation by the OH radicals and the conversion of H_2O_2 to O_2. (auth)

33357 GAMMA RADIOLYSIS OF ALKALINE AND NEUTRAL SOLUTIONS. IV. ALKALINE SOLUTIONS OF SODIUM CHROMITE. Jove, Jose; Haissinsky, Moise (Laboratoire Curie, Paris). J. Chim. Phys., 63: 709-15 (May 1966). (In French).

Sodium chromite in aerated solutions of pH 13.9 is oxidized by γ rays to form the chromate with an initial yield equal, at the plateau of the dilution curve, to G = 10.2 equivalents; hydrogen peroxide is also formed with $G(H_2O_2) = 0.6 \pm 0.2$. Both yields increase with the oxygen pressure, which was varied in these experiments from 0.1 to 6.3 atm. In degassed solution $G(Cr(VI)) = 0.8$, $G(H_2) = 0.4$; H_2O_2 is not detected. The results are compared with the findings of other authors on other solutes irradiated in basic solutions. (auth)

33358 RADIOLYSIS OF MONOMETHYLHYDRAZINE. Shelberg, Wesley E. (Naval Radiological Defense Lab., San Francisco). Nature, 210: 524-6(Apr. 30, 1966).

In an investigation of the effects of ionizing radiation on rocket fuels the radiolytic decomposition of monomethylhydrazine was studied to determine whether the generation of radiolytic gases can be suppressed by the addition of free radical scavengers. (B.G.D.)

33359 EFFECT OF AN ELECTRON-SCAVENGING SOLUTE ON THE RADIOLYSIS OF CYCLOHEXANE. Blackburn, R.; Charlesby, A. (Royal Military Coll. of Science, Shrivenham, Eng.). Nature, 210: 1036-7(June 4, 1966).

The effect of nitrous oxide, used independently and simultaneously with iodine, on yields in gamma radiolysis of cyclohexane was studied. The effect of dose rate on the radiolysis is noted. A mechanism, which accounts for the decrease in hydrogen and the increase in cyclohexyl radical yields, is proposed. (J.G.B.)

33360 EXCHANGE REACTIONS IN THE RADIOLYSIS OF ADSORBED HYDROCARBONS. Dyne, P. J.; Sagert, N. H. (Chalk River Nuclear Labs., Ont.). Nature, 210: 1153-4(June 11, 1966).

The radiolysis of cyclohexane-d_{12} absorbed at low coverages on silica gel was studied using ^{60}Co gamma radiation. The yields of hydrogen and deuterium hydride were much larger than that of deuterium. (D.H.M.)

33361 PULSE RADIOLYSIS OF AQUEOUS EOSIN. Grossweiner, L. I.; Rodde, A. F. Jr.; Sandberg, G.; Chrysochoos, J. (Michael Reese Hospital and Medical Center, Chicago). Nature, 210: 1154-6(June 11, 1966).

The radiolysis of aqueous eosin induced by 1 μsec pulses of 33-Mev electrons from a Linac accelerator at approximately 1,200 rads per pulse was investigated. Flash spectra were taken. Changes in the spectra caused by radiolysis were studied and mechanisms to explain them postulated. (D.H.M.)

33362 RADIOLYSIS OF NITROALKANES. Cundall, R. B.; Locke, A. W.; Street, G. C. (Nottingham Univ., Eng.). Nature, 210: 1354-5(June 25, 1966).

The radiation chemistry of nitromethane, nitroethane, and 1- and 2-nitropropanes was studied. The compounds were exposed to gamma rays from a ^{60}Co source using dose rates between 0.5 and 2.5×10^4 rads hr^{-1}. Higher dose rates up to 7.5×10^6 rads M^{-1} were obtained by means of a linear accelerator. The yield of gaseous products from irradiated nitromethane was drastically reduced if after a short irradiation the samples were immediately quenched in liquid nitrogen until analysis. The decrease in gaseous products was accompanied by an increase in the yield of cis-nitrosomethane dimer. Allowing the sample to stand at room temperature for varying lengths of time increased the yields of N_2, CO, CO_2, and N_2O. Nitrous oxide slightly increased the N_2 and CO yields. G-values are tabulated. (P.C.H.)

33363 NEUTRALIZATION OF HYDRONIUM IONS IN THE RADIOLYSIS OF WATER VAPOR. Johnson, G. R. A.; Simic, M. (Univ. of Newcastle upon Tyne, Eng.). Nature, 210: 1356-7(June 25, 1966).

In studies on the gamma radiolysis of mixtures of D_2O and propane, results that have a bearing on the neutralization of the hydronium ion were obtained. It was found that $G(HD)_t$ (molecules of deuterium hydride per 100 ev absorbed by the mixture of D_2O and propane) as a function of the fraction of energy absorbed in D_2O and in propane, for mixtures with propane concentrations from 2 to 98 mole percent $G(HD)_w = 8.0 \pm 0.5$ and $G(HD)_p = 4.6 \pm 0.4$ (molecules per 100 ev absorbed in D_2O and propane, respectively) are obtained by extrapolation to zero concentrations of propane and D_2O. The observed $G(HD)_p = 4.6 \pm 0.4$ is close to the total yield of positive ions from propane, $G(RH^+)_p = 4.3$. Thus, it seems reasonable to conclude that all the positive ions from $C_3H_8^+$ undergo the proton-transfer reaction and that neutralization of D_3O^+ occurs according to: $D_3O^+ + e^- \rightarrow D + D_2O$. Therefore, it is suggested that in the radiolysis of water vapor, neutralization of hydronium ions by electrons results in the formation of only one hydrogen atom per ion. (P.C.H.)

33364 INFLUENCE OF X RADIATION ON DETERGENT LAMELLA. **Bergeder, H. D.; Koerner, W.; Meissen, H. (Univ., Bonn). Naturwissenschaften, 53: 306-7 (June 1966). (In German).**

Lamella that can be maintained for 70 to 100 sec at a relative humidity of 80 to 82% can be produced from a solution of 0.5 to 1.0 ml Pril (detergent)/l of distilled water with a wire ring slightly inclined from the horizontal. The addition of $CaCl_2$ to the solution doubles the existence time of the lamella. These lamella, however, are extremely sensitive to x irradiation in the second stage of their existence. If the lamella are irradiated during the first half of their existence, there is no effect, but irradiation during the second half of their existence destroys the lamella. The effects of filters were studied. (J.S.R.)

33365 RADIATION-INDUCED SOLID STATE POLYMERIZATION. **Marans, N. S. (W. R. Grace Research Div., Clarksville, Md.). Polym. Eng. Sci., 6: 14-24(Jan. 1966).**

Advantages of using radiation for polymerizing in the solid state are cited: the interaction with a solid throughout its depth in a fairly uniform fashion; and the possibility of functioning either as a radical initiator or as an ionic catalyst for the polymerization. The historical development of radioinduced solid state polymerization is traced and some landmarks in the development of solid state polymerization are listed. Some of the more interesting solid state polymerizations are discussed in detail; then, a general picture of the possible relation between reaction rates in the solid and in the liquid state is given. The most promising potential of radioinduced solid state polymerization is that of obtaining fibers directly from the polymerization. Criteria for predicting radioinduced polymerizability in the solid state are outlined. (TCO)

33366 IRRADIATED POLYETHYLENE. I. FREE RADICAL FORMATION. **Auerbach, I. (Sandia Lab., Albuquerque, N. Mex.). Polymer, 7: 283-92(June 1966).**

Alkyl, and allyl free radical formation in Marlex 50 polyethylene was studied. The free radicals were generated with ^{60}Co γ rays and examined qualitatively and semiquantitatively by electron spin resonance techniques. Irradiations were performed at −196°C. The alkyl radical is relatively stable in the glassy amorphous region of polyethylene and relatively unstable in the viscous-elastic region. Alkyl radical decay takes place by a diffusion process; in the decay process, few of the alkyl radicals, if any, are transformed to allyl radicals. Preliminary results suggest that allyl radical formation at room temperature involves an intermediate other than the alkyl radicals. (P.C.S.)

33367 EFFECT OF γ-IRRADIATION ON STARCH ACIDITY. **Putilova, I. N.; Traubenberg, S. E. (Inst. of Food Technology, Moscow). Prikl. Biokhim. Mikrobiol., 1: 538-43(1965). (In Russian).**

Effects of large doses of ^{60}Co γ-radiation on acidity in potato and corn starch and the effects of Ar, CO_2, and O_2 above the starch in sealed ampules were studied by pH and chromatographic methods. Acidity of the starches and the formation of dissociation constants increased with increasing radiation dose. The radiochemical yield of carboxyl groups was 1.8-fold higher in O_2 than in Ar and 1.4-fold higher than in vacuo. Radiation in a high vacuum increased the acidity more than radiation in O_2, apparently related to the protective effect of moisture. (P.C.S.)

33368 ^{60}Co GAMMA-RAY-INDUCED CARBOXYLATION OF METHYLAMINE. **de la Paz, L. R.; Getoff, N. (Institut fuer Chemie, Vienna). Radiat. Res., 28: 567-75(July 1966).**

The carboxylation of methylamine in aqueous solutions containing CO_2, bicarbonate, or carbonate was studied as a function of radiation dose, pH value, and the concentration of methylamine. Besides glycine, the main carboxylation product, some other amino acids were formed, such as proline, alanine, and small amounts of α,γ-aminobutyric acid. The initial G value of glycine increased from 0.24 at pH 3 to 0.8 at pH 9, and dropped to 0.2 at pH 12. To distinguish between the amino acids and other products formed, $^{14}CO_2$ was used as radioindicator. Probable reaction mechanisms are proposed for the explanation of the experimental results. (auth)

33369 PRODUCT YIELDS FROM ELECTRON-IRRADIATED COTTON CELLULOSE. **Dalton, F. L.; Houlton, M. R. (United Kingdom Atomic Energy Authority, Wantage, Eng.). Radiat. Res., 28: 576-84(July 1966).**

A quantitative study was made of the chain fractures, acid groups, and carbonyl groups produced when a purified cotton cellulose is subjected to irradiation with 4-Mev electrons. A qualitative chromatographic study of the products is also reported. Together with gas yields, which were reported previously, the results allow some discussion of the mechanism of the radiolysis. (auth)

33370 KINETIC STUDIES OF γ-RADIATION EFFECTS ON HYDROGEN ADSORPTION ON γ-Al_2O_3. **Dolidze, G. M.; Kolbanovskii, Yu. A. (Inst. of Physics, Academy of Sciences, Tbilisi Georgian SSR). Soobshch. Akad. Nauk. Gruz. SSR, 42: 51-6(Apr. 1966). (In Russian).**

Samples of γ-Al_2O_3 were given a dose of 5.8×10^6 R, and the hydrogen adsorption by the sample was determined at an initial pressure of 0.1 to 0.6 mm Hg std. The limiting amount of gas adsorbed 10 min after the irradiation was within 10% of the amount of gas adsorbed 3 days after irradiation. The average lifetime of the long-lived adsorption centers was found to be ~10^6 sec. The radiation chemisorption took place primarily on short-lived centers generated by irradiation, as shown by the fact that the amount of adsorbed hydrogen was doubled by storing the irradiated sample at −196°C before testing for hydrogen adsorption. The magnitude of the gamma adsorption effect and its kinetics did not depend on the gas pressure, but was determined by the previous history of the sample such as dose to the sample at −196°C and the amount of adsorbed gas in the intermediate heating-cooling cycles. The average lifetime of the short-lived centers was estimated at 7 min. (TTT)

33371 RADIOLYSIS OF ACETONE SOLUTIONS OF THIOCYANATES. **Ivanitskaya, L. V. (Inst. of Inorganic Chemistry and Electrochemistry, Academy of Sciences, Georgian SSR). Soobshch. Akad. Nauk Gruz. SSR, 42: 85-90(Apr. 1966). (In Russian).**

KCNS and NH_4CNS solutions from 0.001 to 0.1 mole/l were given absorbed energy doses of 0, 0.16, 0.36, 1.8, 3.6, 7.2, and 14.4×10^{20} ev/ml at dose rates of 10^{14} to 10^{16} ev/ml-sec. The thiocyanate concentration decreased steadily with absorbed energy dose with a G value of 15 for 0.10M KCNS and a value of 1.0 for 0.001M KCNS. The G value was 25 for 0.10M NH_4CNS. On decreasing the dose rate from 10^{16} to 10^{14} ev/ml-sec, the G yield for the decomposition of thiocyanate increased by an order of magnitude. The chain reaction is maintained by the two following reactions: $CNS' + HO_2 \rightarrow CNSO_2^- + H$, and $H + O_2 \rightarrow HO_2$. No decomposition of thiocyanate was observed in the absence of oxygen (in a helium atmosphere), even at an absorbed energy dose of 7.0×10^{20} ev/ml. (TTT)

33372 SOME CHARACTERISTICS OF IRRADIATED HB-40: AN ORGANIC LIQUID COOLANT FOR REACTORS. **Arneson, M. C.; Smee, J. L.; Tomlinson, M.; Winters, E. B. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Trans. Amer. Nucl. Soc., 9: 44-5(June 1966).**

33373 TECHNIQUE FOR OBSERVING SHORT-LIVED SPECIES PRODUCED BY PULSED RADIATION. **Klein, N.; Warner, J. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Trans. Amer. Nucl. Soc., 9: 83-4(June 1966).**

33374 CHEMONUCLEAR REACTORS FOR WATER TREATMENT. **Beller, Morris; Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 102-3(June 1966).**

33375 TEMPERATURE DEPENDENCE OF THE HYPERFINE COUPLINGS OF THE RADICALS TRAPPED IN IRRADIATED ETHYL AND n-PROPYL MALONIC ACIDS. Tamura, N.; Collins, M. A.; Whiffen, D. H. (National Physical Lab., Teddington, Eng.). Trans. Faraday Soc., 62: 1037-41(May 1966).

The electron spin resonance spectra of free radicals trapped in irradiated ethyl and n-propyl malonic acids were examined at low temperatures and the anomalous coupling constants previously found at room temperature are shown to be a consequence of considerable motion. (auth)

33376 ELECTRON PARAMAGNETIC RESONANCE OF FREE RADICAL INTERMEDIATES IN THE IRRADIATION OF FROZEN SILVER NITRATE AND SILVER SULFATE SOLUTIONS. Shields, L. (Univ. of Leeds, Eng.). Trans. Faraday Soc., 62: 1042-9(May 1966).

EPR evidence was obtained for reduced silver ions, Ag^0 and Ag_2^+, and oxidized silver ions, Ag^{2+}, in γ-irradiated frozen solutions. The reducing species is attributed to mobile electrons, which are chemically trapped by the solute, and the oxidizing species to the hydroxyl radical and the SO_4^- radical. (auth)

33377 THERMOLUMINESCENCE OF γ-IRRADIATED SOLUTIONS OF AROMATIC COMPOUNDS IN RIGID ORGANIC GLASSES. Brocklehurst, B.; Russell, R. D.; Savadatti, M. I. (Univ. of Sheffield, Eng.). Trans. Faraday Soc., 62: 1129-38(May 1966).

The luminescence of γ-irradiated solutions of aromatic compounds in aliphatic hydrocarbon glasses was studied during and after irradiation at 77°K, during stimulation by infrared radiation at 77°K and on subsequent warming (thermoluminescence). Naphthalene solutions were studied in detail; the relative intensities of fluorescence and phosphorescence vary considerably. The most prominent feature of the thermoluminescence of toluene is emission from the benzyl radical, but this is not observed at 77°K. Trapped ions and electrons were detected by absorption spectroscopy and the luminescences are ascribed to their recombination. (auth)

33378 MATRIX ISOLATION OF UNSTABLE LOWER VALENCY STATES OF METAL CATIONS. Brown, D. M.; Dainton, F. S. (Univ. of Leeds, Eng.). Trans. Faraday Soc., 62: 1139-50(May 1966).

Sulfuric acid glasses of 5.4 M containing various metal sulfates were irradiated with γ rays at 77°K. The results show that electrons are formed, which can travel at least 30 Å, and on encounter with cations, M^{n+}, can reduce these to $M^{(n-1)+}$ where $M^{n+} = Mn^{2+}$, Co^{2+}, Ni^{2+}, Ga^{3+}, Ag^+, Cd^{2+}, In^{3+}, and Tl^+. The spectra of the isoelectronic species Ag^0, Cd^+, and In^{2+} are tentatively assigned to the common transition $5^2P_{\frac{3}{2}}$ or $\frac{1}{2} \leftarrow 5^2S_{\frac{1}{2}}$. Relative electron trapping efficiencies for the ions $Ag^+ : Cd^{2+} : In^{3+}$ at 77°K are 1.0 : 0.54 : 0.67, respectively. In addition to electrons, oxidizing species, considered to be SO_4^-·, are formed, which have a broad absorption $\lambda_{max} = 444m\mu$. On warming, this species decays and in glasses containing Mn^{2+}, Ag^+, and Tl^+ there is evidence for the formation of Mn^{3+}, Ag^{2+}, and Tl^{2+}. (auth)

33379 GAMMA RADIOLYTIC OXIDATION OF CYCLOHEXANE. Blackburn, R.; Charlesby, A. (Royal Military Coll. of Science, Swindon, Eng.). Trans. Faraday Soc., 62: 1159-68(May 1966).

The liquid-state yields of cyclohexanol and cyclohexanone obtained by the gamma radiolytic oxidation of cyclohexane were measured, both in the absence and presence of sulfur, and the radical scavenger, iodine. In the absence of these additives the yields of ketone and alcohol are similar and the major part of these products is accounted for by a mechanism involving the formation and disproportionation of cyclohexylperoxy radicals. The presence of iodine reduces the yields of both the alcohol and the ketone, as predicted by the disproportionation mechanism, the low residual yields at high iodine concentration suggesting that non-radical processes do not make any important contribution. This conclusion is further substantiated by a kinetic analysis of the results. In the presence of sulfur the yield of ketone is greatly reduced while that of alcohol is much less affected. This is attributed to preferential formation of the cyclohexanol by the reaction of sulfur intermediates with oxidizing radicals and products. Solid-state yields of both alcohol and ketone are lower than those obtained in liquid; this is attributed to a lower equilibrium concentration of oxygen in the solid, and possibly to a reduced mobility of both oxygen and radicals at low temperatures. The relatively greater reduction in the alcohol yield is attributed to a steric effect imposed by the solid lattice leading to inhibition of cyclohexylperoxy radical disproportionation. The validity of vapor-phase chromatography as a method of analysis in such studies is also discussed. (auth)

33380 KINETICS OF THE RADIOLYSIS OF CHLOROFORM: COMBINED EFFECTS OF DOSE RATE AND TEMPERATURE. Abramson, Fred Paul. Columbus, Ohio, Ohio State Univ., 1965. 107p.

Thesis.

The combined effects of dose rate and temperature as well as the effect of dosage were investigated in the Co-60 γ-ray radiolysis of liquid chloroform. The products that were carefully studied are CH_2Cl_2, CCl_4, C_2Cl_4, $C_2H_2Cl_4$, C_2HCl_5 and C_2Cl_6. At room temperature the G values for H_2 and Cl_2 were determined. A number of minor products were observed, but their yields were not determined. The G values for the products studied exhibited no dosage dependence except for Cl_2, which appeared to achieve a steady-state concentration. The combined effects of dose rate and temperature were investigated at six temperatures between −57° and +63°C at 4.85 and 0.588×10^{19} ev/g-hr dose rates to a total dose of 10^{20} ev/g. These results were discussed in terms of two physical models, which showed that the distribution of intermediates is much broader than for many other compounds. The presence of a solvent that can capture electrons is used for an explanation of this broad distribution. A mechanism of 31 reactions was proposed and discussed. In particular, the reaction $CHCl_2\cdot + CHCl_3 \rightarrow CH_2Cl_2 + CCl_3\cdot$ was discussed, the rate constant and activation energy were determined, and the steric factor was evaluated. (Dissertation Abstr.)

33381 BEITRAG ZUR STRAHLENCHEMIE DES EISENPENTACARBONYLS, INSBESONDERE IN GEGENWART VON PHILODIENEN. (Contribution to the Radiation Chemistry of Iron Pentacarbonyls Especially in the Presence of Philodienes). Jun, Mong-Jon. Aachen, Rheinisch-Westfaelische Technische Hochschule, 1966. 130p.

Thesis.

The radiation chemistry of $Fe(CO)_5$ in organic solvents is described by the following equations: $Fe(CO)_5 \rightarrow Fe(CO)_5^*$ (1), $Fe(CO)_5^* + Fe(CO)_5 \rightarrow Fe_2(CO)_9 + CO$ (2), $3Fe(CO)_5 \rightarrow 3Fe(CO)_4 + 3CO$ (3), and $3Fe(CO)_4 \rightarrow [Fe(CO)_4]_3$ (4). The optically permitted excitation states of $Fe(CO)_5$ were quenched by $Ni(CO)_4$. $Ni(CO)_4$ stops reaction (2) but not reaction (4). $Fe(CO)_5$ in benzene with MSA, FSM, MSM, MASM, and VA (maleic anhydride, dimethyl ester of fumaric acid, dimethyl ester of maleic acid, methyl ester of methacrylic acid, and vinyl acetate) yields, photochemically and radiochemically, the corresponding iron tetracarbonyl complexes. The polymerization of methyl methacrylate in the presence of iron tetracarbonyl is accompanied by simultaneous foaming. The mechanism of this reaction is discussed. ^{60}Co γ irradiation of $Fe(CO)_5$ in CCl_4 and $CHBr_3$ yields the corresponding dimers of halogenmethyl-iron tricarbonyl halogenides. By radiochemical transformation of $Fe(CO)_5$ with nitrobenzene nitrosobenzene-iron tricarbonyl dimers are formed. The experimental techniques used are described. (tr-auth)

33382 FLAVOR CHEMISTRY OF IRRADIATED MILK FAT. Khatri, Lakho Lilaram. Corvallis, Oreg., Oregon State Univ., 1966. 157p.

Thesis.

Milk fat, prepared from raw sweet cream and washed free of phospholipids, was first irradiated in the presence of air and under vacuum in glass vials at 4.5 Mrad with gamma rays from cobalt-60. The irradiation resulted in

increase in TBA number, peroxide value, total monocarbonyls, bleaching of color, slightly rancid and typical candle-like off-flavors. Free fatty acids were also produced upon irradiation. The changes were more drastic in air along with production of a slight oxidized flavor. The monocarbonyls identified by column and paper chromatographic methods in irradiated milk fat include: C_1 through C_{12}, C_{14}, and C_{16} n-alkanals; C_3 through C_9, C_{11}, C_{13}, and C_{15} alk-2-ones with only traces of C_6 and C_8 alk-2-ones; and C_5, C_6, C_9, and C_{12} alk-2-enals. For identification of volatile components, the milk fat was irradiated in enameled cans under vacuum. The headspace analysis showed some air still left in the cans. Irradiation resulted in consumption of oxygen and production of hydrogen, carbon monoxide, carbon dioxide, and methane as identified in the headspace gases. The volatiles were isolated from the irradiated and control milk fats and identified on the basis of mass spectral data and coincidence of gas chromatographic retention times. The volatile compounds positively identified in irradiated milk fat were n-alkanes(C_5 through C_{17}), 1-alkenes(C_5, C_7 through C_{17}), fatty acids(C_4, C_6, C_8 and C_{10}), n-alkanals(C_5 through C_{11}), γ-decalactone, δ-decalactone, 2-heptanone, benzene, ethyl acetate, chloroform, and dichlorobenzene. Possible reaction mechanisms are presented for the formation of the compounds in irradiated milk fat. (TCO)

33383 ELECTRON SPIN RESONANCE STUDIES OF RADICALS PRODUCED IN GLASSY AND POLYCRYSTALLINE ALKYL IODIDES BY GAMMA RADIOLYSIS. Fenrick, Harold William. Madison, Wis., Univ. of Wisconsin, 1966. 122p.

Thesis.

Glassy and polycrystalline forms of five alkyl iodides were gamma irradiated to a dose of 7×10^{19} ev/g at 77°K at a dose rate of 3.5×10^{18} ev/g-min using a ^{60}Co gamma source. Electron spin resonance examinations were made using a Varian V-4500 spectrometer. The spectra obtained for polycrystalline samples of alkyl iodides with an even number of carbon atoms in the alkyl chain contained many more lines, covered a much larger gauss range, and were much less intense than the spectra obtained for glassy samples of these compounds and for polycrystalline compounds with an odd number of carbon atoms in the alkyl chain. The spectra obtained for the polycrystalline forms were much more stable than the spectra obtained for the glassy forms. The spectra obtained for glassy samples of alkyl iodides of carbon atom chain length three and longer were identical in appearance and nearly equal in intensity. Polycrystalline samples of n-propyl, n-butyl and n-amyl iodide gave spectra that changed on standing several days at 77°K. The spectra of both the glassy and polycrystalline forms were detectable for several months at 77°K. The spectra appeared to decay with a first order decay rate for the first few days after irradiation and with a second order decay rate after several weeks at 77°K. Isotopic substitution studies using C_2D_5I and ethyl iodide-I^{129} were carried out. The results rule out hyperfine splitting due to hydrogen or iodine as the cause of the complex spectra obtained for the polycrystalline even-numbered alkyl iodides. The equal spreads of the spectra from protonated and deuterated ethyl iodide indicate that iodine is responsible for the wide spread of these spectra. The fact that the wide spread spectra are obtained only for the even-numbered iodides could be due to a difference in the crystal structure of the even and odd-numbered alkyl iodides. (TCO)

33384 ENERGY TRANSFER IN RADIATION PROCESSES. CHEMICAL, PHYSICAL AND BIOLOGICAL ASPECTS. **Proceedings of the International Symposium Held at Cardiff, January 1965. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966. 195p. $12.00. (CONF-650121).**

Separate abstracts have been prepared for 17 of the 20 papers. The three papers not abstracted deal with a general introduction to energy transfer processes, physical aspects of energy transfer in radiation processes, and biological aspects of energy transfer in biological processes. (B.L.M.)

For abstracts of individual papers see: 32938–32940, 33075, 33076, 33273, 33385–33393, 34827, and 34828.

33385 ENERGY TRANSFER IN CARBOHYDRATE SYSTEMS. **Phillips, G. O.; Baugh, P.; Young, M. (Univ. of Wales, Cardiff). pp 14-28 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.**

The results of experiments which indicate that energy transfer may occur efficiently in carbohydrates are summarized. Particular attention is directed to chemical manifestations of energy transport processes. Gamma rays from a ^{60}Co source were the irradiating energy. Energy transport within glucose crystals was best explained by the exciton model. The electron-spin-resonance spectra of γ-irradiated cyclic oligosaccharides (the Schardinger dextrins) were studied in an attempt to demonstrate intermolecular energy transfers. Transfer of the electronic energy from the carbohydrate to the included molecule was found to provide a satisfactory account for the observations. (B.L.M.)

33386 INTRAMOLECULAR ENERGY TRANSFER IN CELLULOSE AND RELATED MODEL COMPOUNDS. **Arthur, Jett C. Jr. (Southern Regional Research Lab., New Orleans). pp 29-36 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.**

The energy transfer effects in solid glycosides and cellulose, leading to localization of the energy within a molecule and resulting in its degradation, were investigated following gamma irradiation from a ^{60}Co source. The intramolecular transfer and localization of energy were followed by determination of the yield of selected chemical changes, the e.s.r. spectra, and in the case of fibrous cellulose, selected physical properties of the high polymer. Results demonstrate that substitution of benzoyl groups on the carbohydrate molecule affects intramolecular energy transfer over distances greater than one glucose unit for the glycosides and in cellulose over distances as great as seven cellobiose units. (B.L.M.)

33387 INTER- AND INTRA-MOLECULAR ENERGY TRANSPORT IN POLYMETHYL METHACRYLATE. **Gardner, D. G.; Henry, G.; Ward, D. (Illinois Inst. of Tech., Chicago). pp 37-59 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966. (COO-1224-7).**

Some preliminary data from a study of the energy transfer in noncrystalline organic material are presented. Two types of experiments are described. In the first, samples of normal polymethyl methacrylate, PMMA, (mainly syndiotactic form), samples of ~100% isotactic PMMA, and solid solutions of these two forms were irradiated with high energy electrons. The amount of degradation that occurred, as a function of dose, was measured in each case. In the second type of experiments, samples of PMMA containing an energy sink such as a benzene ring, in solid solution or attached to the polymer chain, and in addition containing a scintillator p-terphenyl in solid solution were exposed to a small β-ray source, and the relative amount of energy appearing as light was determined. A preliminary interpretation in terms of an energy transfer mechanism is given. (B.L.M.)

33388 THE cis-trans ISOMERIZATION OF OLEFINES BY TRIPLET-TRIPLET ENERGY INTERCHANGE IN IRRADIATED BENZENE. **Cundall, R. B.; Griffiths, P. A. (Univ. of Nottingham, Eng.). pp 60-71 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.**

Various aspects of the cis-trans isomerization of olefins are compared in both the photochemical and radiation systems. Previous works in both fields are reviewed. Theoretical considerations of the mechanism of the electronic energy transfer processes for the isomerization are discussed. A ^{60}Co source and pulsed electron beams were

used to study the radiation-induced isomerization. All results indicate that the triplet state is involved, but no direct information on the process leading to the triplet state production is provided. The relative efficiencies of certain additives in deactivating the triplet state of benzene are presented also. (B.L.M.)

33389 ENERGY TRANSFER IN PULSE RADIOLYSIS OF SOME ORGANIC SYSTEMS. Kemp, T. J. (Univ. of Leeds, Eng.); Salmon, G. A.; Land, E. J.; Nosworthy, Judith M. pp 72-84 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

A survey is presented on electron pulse radiolysis of solutions of organic systems and on the spectroscopic identification of products of the irradiated solutions. Studies on the mechanism of formation of the triplet state of the hydrocarbon solvent are discussed, and the transfer of absorbed energy to solute molecules at some distance from the point of initial deposition is considered. (M.J.T.)

33390 ELECTRON MIGRATION IN GLASSY SOLIDS AT LOW TEMPERATURES. Dainton, F. S.; Salmon, G. A. (Univ. of Leeds, Eng.). pp 85-92 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

A review is presented of the salient features of work on electron trapping and migration in low-temperature (77°K) glasses. Both optical and e.s.r. spectra are presented for several systems. Experiments are described which provide information concerning mobility and reactivity of electrons that are liberated from the medium by the action of ionizing radiation. (B.L.M.)

33391 ENERGY TRANSFER PROCESSES DURING DISSOLUTION OF IRRADIATED SUBSTANCES STUDIED BY LUMINESCENCE MEASUREMENTS. Ahnstroem, Gunnar (Royal Univ., Stockholm). pp 114-20 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

Two reaction mechanisms are suggested for the energy transfer that occurs when alkali halides, irradiated with doses ranging from a few rad up to one Mrad, are dissolved in a solution containing a suitable fluorescent substance to give a light yield per unit dose that increases with an increasing total dose. An equation giving the relative contribution of interphase reactions and reactions in solution to the total luminescence yield as a function of the concentration of radiation-induced trapped electrons and holes is proposed. Quenching by various agents of the luminescence produced by the dissolution of the irradiated alkali halide in a solution containing fluorescein is discussed for two types of agents. One type includes molecules such as O_2, NO_3^-, acetone, and H_3O^+, which are known as e_{aq}^- scavengers, and the biological electron acceptor, TPN^+. Reducing agents such as SO_3^{2-} and the biological electron donor, TPNH, also quenched the luminescence. (B.L.M.)

33392 PARTITION OF ABSORBED ENERGY AMONG THE COMPONENTS DURING THE IRRADIATION OF MIXTURES. Swallow, A. J. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). pp 121-4 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

The processes by which fast charged particles transfer their energy to matter during the irradiation of mixtures of components are considered. The activation of valence electrons of the molecules is the most important radiation-induced process; thus in homogeneous mixtures energy should be partitioned according to the fraction of valence electrons of each component. However, this does not hold true for compounds containing π-electrons, and special consideration is given the energy partition in mixtures of π-electron containing compounds. (B.L.M.)

33393 MOLECULAR EXCITON THEORY—SOME APPLICATIONS IN CHEMISTRY AND BIOLOGY. Mason, R. (Univ. of Sheffield, Eng.). pp 127-36 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

Published work on several aspects of the molecular exciton theory is reviewed, and the theory is applied to both ideal and real polymers. Its application to the interpretation of the absorption spectra of helical protein and nucleic acids is discussed, as well as its importance in determining the optical rotatory properties of the biopolymers. The exciton theory is proposed as a possible explanation for the energy transfer processes in the radiation inactivation of enzymes and in photosynthesis. (B.L.M.)

33394 A MIXED PHOTOPRODUCT OF URACIL AND CYSTEINE (5-S-CYSTEINE, 6-HYDROURACIL). A POSSIBLE MODEL FOR THE IN VIVO CROSSLINKING OF DNA AND PROTEIN BY ULTRAVIOLET LIGHT. Smith, Kendric C.; Aplin, Robin T. (Stanford Univ., Palo Alto, Calif. Oxford Univ.). 26p. (CONF-650221-5). ORAU. From Biophysical Society, 9th Annual Meeting, San Francisco.

A heterodimer of uracil and cysteine (5-S-cysteine, 6-hydrouracil) has been produced by irradiating a solution of uracil-2-C-14 (2.8×10^{-3} M) and cysteine-HCl (10^{-2} M) with uv radiation (2537Å). A simple technique for the bulk isolation of this photoproduct using ion exchange chromatography and cuprous oxide precipitation of free cysteine is described. The heterodimer is not uv absorbing, is ninhydrin positive and contains sulfur as judged from experiments using cysteine-S-35. The structure of this photoproduct was determined using uv, NMR, and mass spectroscopy. Treating the photoproduct with deuterated Raney Nickel yields 5-monodeutero dihydrouracil; thus confirming the point of attachment of the cysteine. Raney Nickel treatment also yields alanine. 5-S-cysteine, 6-hydrouracil-HCl is stable to heat (100°) in water solution and is stable to 6N HCl at room temperature but is not stable to the heat and acid conditions used for the hydrolysis of DNA. It is quite unstable to alkali. R_f values for this heterodimer in several solvents are tabulated. 5-S-cysteine, 6-hydrouracil may serve as a model for the mechanism by which DNA and protein are crosslinked in vivo by uv irradiation. The photochemical addition of cysteine-S-35 to polyuridylic acid, polycytidylic acid and to DNA lend support to this hypothesis. (auth)

33395 METHOD FOR PRODUCING A SAFE AND SECURE MATERIAL TO BE EMBEDDED IN THE HUMAN BODY. Fujimoto, E. Japanese Patent 1965-12,999. June 24, 1965. Filed Jan. 19, 1962.

A method is proposed for producing a dimethylpolysiloxane gel, which, when embedded in the human body, is safe, giving no harmful biological effect. The body is prepared by placing a mixture of a dimethylpolysiloxane oil of over 300 centistokes in viscosity and a bridging agent, such as laurylperoxide, methylethylketoneperoxide, or tertbutylperoxide, in a glass vessel and irradiating the mixture with gamma rays from ^{60}Co at 0 to 100°C at doses of 2 to 6 MR. The irradiated substance is then mixed with a large quantity of pure ethanol and boiled for 1 to 3 hours. After cooling, the gel is separated from the alcohol and washed three times with small amounts of pure ethanol. The washed gel is put into a large volume of distilled water and boiled 1 to 3 hours. Finally, the gel is placed on an evaporation plate and heated at 120 to 130°C for 30 to 60 minutes to obtain the final product. (NSA of Japan)

Radiochemistry

See also Separation Processes and Procedures

Refer also to abstract 33424.

33396 (NAS-NRC-1351) SOURCE MATERIAL FOR RADIOCHEMISTRY. Nuclear Science Series Report No. 42. (National Academy of Sciences–National Research Council, Washington, D. C.). 1965 Revision. 82p. National Academy of Sciences, Washington, D. C. $1.50.

A listing is presented of books, reviews, and journal articles covering basic nuclear chemistry and nuclear

physics, radiochemical separations and counting techniques, compilations of useful data, solvent extraction and ion exchange techniques, activation analysis, information on obtaining radioisotopes, the design of radiochemical laboratories, radiological safety, and applications to some major fields of concern to the chemist. With one exception only readily available literature in the English language is included. Material to June 1965, with a few later entries, is included. (M.C.G.)

33397 PREPARATION OF ^{82}Br OF HIGH SPECIFIC ACTIVITY. Mani, R. S. (Atomic Energy Establishment, Trombay, India). Curr. Sci. (India), 35: 305-6(June 20, 1966).

The preparation of high specific activity ^{82}Br by recoil enrichment is examined. Pure p-dibromobenzene or disodium phenol tetrabromophthalein disulfonate is used as a target, and after irradiation, the ^{82}Br is separated out by solvent extraction or column chromatography. (B.G.D.)

33398 TRACER STUDY OF THE REACTIONS OF IONIC INTERMEDIATES FORMED BY NUCLEAR DECAY OF TRITIATED MOLECULES. I. METHANE-t_4. Cacace, Fulvio; Ciranni, Giovanna; Guarino, Angelo (Univ., Rome). J. Amer. Chem. Soc., 88: 2903-7(July 5, 1966).

A tracer technique was employed to identify the stable products from the reactions of ionic intermediates formed on decay of a tritium atom contained in a methane molecule. Methane-t_4 was allowed to decay in methane and in methane-propane mixtures, in the presence of oxygen, at atmospheric pressure and room temperature. Such a technique, combined with the available mass spectrometric data on the decay-induced fragmentation of monotritiated methane, and taking into account the ion-molecule reactions that occur in the systems investigated, was employed to derive the chemical fate of a methane molecule following the decay of a constituent tritium atom. The results suggest that the decay in systems at 760 torr produces a fragmentation pattern similar to that observed at low pressure in the mass spectrometer. In fact, taking into account the mass spectrometric data on the abundance of the organic ions from the decay of CH_3T and their known reactions in the systems investigated, it is possible to predict the nature and the yields of the observed final products and the dramatic changes caused by the addition of propane. Results suggest that the decay of multilabeled molecules could afford a valuable tool to study such processes in systems at high pressure or even in the liquid state. (auth)

33399 ANALYSIS OF GAMMA-GAMMA COINCIDENCE METHOD USED FOR STANDARDIZING ^{60}Co AND ^{22}Na SOURCES. Garapov, E. F.; Gryaznov, Yu. N. Prib. Tekh. Eksp., No. 6, 72-7(Nov.-Dec. 1965). (In Russian).

An analysis of the γ-γ coincidence method used for the measurement of the activity of radioactive sources of ^{60}Co and ^{22}Na was carried out. Formulas were given for corrections to the probability of the registration of γ quanta of different energies, the angle of correlation, the final geometric dimensions, and counting errors connected with the dead time of the apparatus used. The question on the determination on the minimum time necessary for obtaining the precision required was examined. (tr-auth)

33400 ISOMER EFFECTS IN β DECAY OF RaE WITH o-, m-, p-TOLYL DERIVATIVES OF BISMUTH. Nefedov, V. D.; Vobetsky, M; Sinotova, E. N.; Borak, I. Radiokhimiya, 7: 627-8(1965). (In Russian).

Bismuth metal was irradiated in a reactor to prepare ^{210}Bi (RaE with $T_{\frac{1}{2}}$ = 5.0 days). The ortho, meta, and para tolyl derivatives of bismuth [o-, m- or $(p\text{-}C_7H_7)_3$ Bi] were synthesized, and the decay products were allowed to accumulate. The compounds were then analyzed by thin-layer chromatography on Al_2O_3. For the ortho and para derivates, the yield of R_3PoX type of compounds was 67% and the yield of R_2Po type of compound was 33%. With the meta derivative the yields were reversed with 39% for the R_3PoX type of compound, and 61% for the R_2Po type of compound. The position of the substituent in the benzene ring had an effect on the stability of the molecular ion formed during the beta decay of ^{210}Bi incorporated in various isomeric tolyl derivates of bismuth. (TTT)

33401 SYNTHESIS OF THE p-XYLYL DERIVATIVES OF POLONIUM IN β DECAY OF RaE IN ANALOGOUS BISMUTH DERIVATIVES. Nefedov, V. D.; Vobetsky, M.; Borak, I. Radiokhimiya, 7: 628-9(1965). (In Russian).

The compounds $(p\text{-}C_8H_9)_3Bi$ and $(p\text{-}C_8H_9)_3BiCl_2$ containing ^{210}Bi ($T_{\frac{1}{2}}$ = 5.0 days) were synthesized by standard methods. The decay products were allowed to accumulate in the crystal lattice at room temperature, and were analyzed by thin-layer chromatography on Al_2O_3. With $(p\text{-}C_8H_9)_3Bi$ as the parent substance, the yields were 67% for the R_3Po X type of compound, and 33% for the R_2Po-type compound. With $(p\text{-}C_8H_9)_3BiCl_2$ as the parent substance, the yields were 44% for the R_3PoX-type compound, and 56% for the R_2PoX_2-type compound. These p-xylyl polonium derivatives were prepared and identified for the first time. (TTT)

33402 PREPARATION OF ^{54}Mn OF HIGH SPECIFIC ACTIVITY FROM IRON IRRADIATED IN A REACTOR. Bebesel, Pavel L.; Turcanu, Corneliu N. (Institut de Physique, Bucharest). Rev. Roum. Chim., 11: 441-4 (Mar. 1966). (In Rumanian).

A method for the preparation of ^{54}Mn of high specific activity and of high radiochemical purity from an iron target irradiated in a reactor is presented. ^{54}Mn is separated from iron by transformation into manganese hydroxide and concentration on an alumina column. The method assures the high specific activities with a yield of approximately 90%. (tr-auth)

33403 THEORETICAL CALCULATIONS OF SELF-ABSORPTION IN GAMMA-RADIATION SOURCES. Galanter, L.; Kuhl, O. A. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 97-8(June 1966).

33404 MONTE CARLO CALCULATION OF SELF-ABSORPTION AND SCATTERING BY CYLINDRICAL ENCAPSULATED GAMMA-RAY SOURCES. Preiss, Kenneth (Univ. of Illinois, Urbana). Trans. Amer. Nucl. Soc., 9: 98-9(June 1966).

33405 ANALYSIS OF DECAY CURVES FOR SIMPLE AND COMPLEX THEORETICAL AND EXPERIMENTAL RADIOACTIVE MIXTURES BY COMPUTER AND PLOTTING TECHNIQUES. Fairman, William D.; Tyler, Sylvanus A.; Dipert, Merlin H.; Sedlet, Jacob (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 99 (June 1966).

33406 PURIFICATION OF ^{14}C-LABELED COMPOUNDS BY PREPARATIVE GAS CHROMATOGRAPHY. Baret, C. (CEN, Gif-sur-Yvette, France). 11p. (CONF-650842-1). ORAU. Gmelin, AED-CONF-65-228-2.

From International Symposium on Microchemical Techniques, University Park, Pa.

The isolation and purification of a few ^{14}C labeled compounds of high specific activity (e.g., benzene, toluene, acetone, methanol, stearic acid, indole) has been effected on a 0.1 to 1 g scale (and up to 100 mC) by gas chromatography. The construction and performance of two improved assemblies are described, one employing a glass column and the other a stainless steel one. Both are easily disassembled for decontamination. A compound to be purified is transferred on the vacuum line and sealed in a special glass ampule which is placed into a special injection device and broken. The sample is vaporized into a helium stream. The effluent composition is followed continuously by two detectors in series: a katharometer for weight determination and an end-window (1.2 mg/sq cm) Geiger-Mueller tube modified for operation up to 200°C. The minimum detectable activity is 0.1 μC for ^{14}C. Samples are collected in cold traps, the cores of which are heated to avoid fog formation or loss of material. Samples are then recovered by transfer on a vacuum manifold or by solution in a suitable solvent. (auth)

Separation Processes and Procedures

See also Analytical Procedures
ISOTOPE TECHNOLOGY — Separation and Production

Refer also to abstracts 34550, 35025, 35106, and 35177.

33407 (ANL–7134) PROCESSING OF ROCK DEBRIS FOR TRANSPLUTONIUM ELEMENTS PRODUCED BY UNDERGROUND NUCLEAR DETONATIONS. Horwitz, E. P.; Bloomquist, C. A. A.; Harvey, H. W.; Hoh, J. C. (Argonne National Lab., Ill.). Feb. 1966. Contract W-31-109-eng-38. 24p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Chemical processes used for recovery of transplutonium elements and Pu from rock samples from underground nuclear explosions are described. Recovery efficiencies using the described procedures are estimated to be better than 90% on a kilogram scale. (J.R.D.)

33408 (ANL–7153) INDUCTION PROBE FOR MEASURING LIQUID LEVELS IN LIQUID METALS. Johnson, T. R.; Teats, F. G.; Pierce, R. D. (Argonne National Lab., Ill.). Feb. 1966. Contract W-31-109-eng-38. 24p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A mutual-inductance probe was developed to determine the location of the interface between gas and liquid metal and between liquid salt and liquid metal. The probe is a bifilar winding of Nichrome wire on an alumina form contained in a Type 304 stainless steel or a ceramic well. A high-frequency voltage supplied to one winding induces a voltage in the second winding, that can be related to the depth of liquid surrounding the coil. Probes, approximately 5 and 14 in. long, were calibrated in liquid Cd, Bi, and Na at 200 to 700°C. The output signal was only slightly affected by the metal resistivity at 20 to 140 μohm-cm. The response was influenced by the temperature of the probe. A simplified procedure for calibrating the probe is discussed. Although developed primarily for use in nuclear-fuel recovery processes that employ liquid metals as solvents, the device has several important advantages over other means of measuring liquid levels. It is compact, rugged, reliable, and reasonably accurate. The average deviation in measured liquid level was 2 to 3% of probe length. The instrument is well adapted to operations in remotely operated facilities, because it has no moving parts and can be replaced easily. (auth)

33409 (CONF-660308, pp 92-4) PLUTONIUM PROCESSING CAPABILITIES OF NUCLEAR FUEL SERVICES. Johnson, E. R. (Nuclear Fuel Services, Inc., [Washington, D. C.]).

Nuclear Fuels Services is developing a significant Pu processing capability in early anticipation of the use of Pu in thermal reactors and fast reactor fuel development. A summary of this capability is presented. (M.O.W.)

33410 (CONF-660308, pp 95-100) PLUTONIUM CAPABILITIES AT ATOMICS INTERNATIONAL. Pearlman, Harry (Atomics International, Canoga Park, Calif.).

The facilities at Atomics International for processing plutonium fuels are described. (M.O.W.)

33411 (IDO–14674) AN IMPROVED AQUEOUS PROCESS FOR ZIRCONIUM ALLOY NUCLEAR REACTOR FUELS. PART III. CONTINUOUS DISSOLUTION IN HYDROFLUORIC ACID WITH SOLUBLE POISON. Newby, B. J.; Rohde, K. L. (eds.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). June 1966. Contract AT(10-1)-205. 23p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The CPP Monel-400 batch dissolver was recently converted to semi-continuous operation to provide higher capacity reprocessing facilities. The semi-continuous operation required that about 4 g/l B be present to make the operation critically safe. Process development studies leading to the higher capacity operation are reported. Laboratory dissolution studies in a one-in.-dia. continuous dissolver using 5M HF–0.03M HNO_3–4 g/l B to dissolve 2.2 to 2.5% U–Zircaloy-2 fuel showed that the dissolver product is suitable for complexing into extraction feed. Operation of a 3.5-in.-dia. pilot plant dissolver simulating the ICPP semi-continuous dissolver operation showed only traces of U solids formed in the dissolver during operation and that a 16-hr charging-dissolution schedule was possible and adequate to meet production needs. U solids adhering to dissolver walls were dissolved in 0.1M chromic acid. Uranium-235 is not expected to build-up during dissolver operation because the meat of irradiated fuel has been shown to dissolve faster than its cladding material. B was shown to stay in the dissolver product solution at all times even during excessive evaporation and precipitation of uranium or zirconium fluoride. (auth)

33412 (IEA–109) CONCENTRATION AND PURIFICATION OF ^{137}Cs FROM FISSION PRODUCTS. Rivas, F. J.; Abrao, A.; Lima, F. W. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Dec. 1965. 14p. Dep. mn.

Conditions are described for the concentration and purification of ^{137}Cs, starting from its recovery from fission products by co-crystallization in the form of ammonium alum. ^{137}Cs was recovered from the alum following dehydration, calcination, leaching, purification by ion-exchanger, and concentration. Results of a study on the thermo-gravimetric decomposition of the ammonium alum containing ^{137}Cs indicate that there is no loss of Cs when the alum was dehydrated to 250°C and calcined from 250 to 800°C. The residue (Al_2O_3) containing all of the ^{137}Cs was leached with 1M HCl, 92 to 94% of ^{137}Cs being extracted. ^{137}Cs was purified by ion-exchanger technique resulting in a highly radiochemically pure product. (J.R.D.)

33413 (K–1669) ORGDP FUEL REPROCESSING STUDIES SUMMARY PROGRESS REPORT, JULY THROUGH DECEMBER, 1965. Smiley, S. H.; Brater, D. C.; Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 28, 1966. Contract W-7405-eng-26. 56p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

Processes aimed at purifying and recovering U and Pu from spent nuclear reactor fuels by volatilization as the respective hexafluorides were investigated. Two main phases including preparation of conceptual plant studies with concomitant definition of problem areas associated with the process technology; and component development, including scale-up and testing of crucial process equipment and auxiliaries are described. Topics covered include status of the conceptual study of the multipurpose fluid-bed plant for high enrichment fuels; status of low enrichment fuel flow sheet studies; composition of irradiated fuels; theoretical aspects of UF_6–PuF_6 fission product separation by distillation; design of a reactor for producing BrF_5 from BrF_3; sizing of condenser systems for collection of BrF_5–UF_6 mixtures; NaF fluid-bed sorber criticality calculations; corrosion testing and related studies; process and reactor studies, including cold semiworks plant design; outlet gas filter testing; product purification sorption-desorption system using batch NaF pellet traps; connector testing; status of value selection; peripheral and diaphragm compressor evaluation; and reactor fabrication procedures. (auth)

33414 (ORNL-P-2192) RECENT DEVELOPMENTS IN THORIUM FUEL PROCESSING. Nicholson, E. L.; Ferris, L. M.; Flanary, J. R.; Goode, J. H.; Hannaford, B. A.; Landry, J. W.; Moore, J. G.; Rainey, R. H.; Watson, C. D.; Witte, H. O. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 42p. (CONF-660524-6). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From 2nd International Thorium Fuel Cycle Symposium, Gatlinburg, Tenn.

Three head-end processes are being developed for thorium-base power reactor fuels. The processes are: shear-leach for metal-clad oxides and either grind-leach or burn-

leach for graphite-base High-Temperature Graphite Reactor (HTGR) fuels. Shear-leach studies were made on secondary problems associated with the process. These studies included calculation of the fuel temperature during the various process steps, measurement of the release of krypton and tritium during processing, the zirconium-metal fines safety problem, development of an instrument for monitoring hulls for leaching losses, and shearing tests on second-generation fuel elements. Grind-leach process studies were done in the laboratory and in small-engineering-scale experiments with unirradiated HTGR fuel. Grinding, leaching, and washing conditions were determined for satisfactory recovery of the uranium and thorium. Engineering problems associated with grinding graphite and filtering graphite slurries are also being studied. For the burn-leach process, estimates were made of the fission-product activity in the off-gas from a fluidized-bed burner. Fission product behavior and other problems associated with burn-leach processing are being studied in hot-cell experiments. Other studies include protactinium recovery by adsorption on unfired Vycor glass, and chemical and engineering studies of a close-coupled processing plant in which simplified, low-cost, limited-decontamination processing methods are used to prepare feed materials for an associated fuel-fabrication plant operated by remote control. (auth)

33415 (RL-SEP-722) FLAT BED GAS-SOLIDS CONTACTOR. Fullam, H. T. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 17, 1965. Contract AT(45-1)-1350. 22p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A flat bed gas-solids contactor was designed and evaluated on a laboratory scale. The unit is safe, easy to scale up, gives excellent gas-solids contact, is operationally insensitive to gas and solid feed rates, and is simple to operate. Two reactions studied in the unit were the hydrofluorination of PuO_2, and the H_2 reduction of UO_3. Good fluoride conversions were obtained at reasonable throughputs and operating temperatures when decomposed oxalate oxide or direct calcined oxide containing an activating agent were used. Hydrogen reduction of UO_3 was demonstrated although maximum throughputs were not determined. The feasibility of the contractor design for halogenation and H_2 reduction of fissile materials was demonstrated. (J.R.D.)

33416 (UJV-1498) THE EQUIPMENT FOR THE REPROCESSING OF IRRADIATED FUEL IN HOT CELLS IN THE INSTITUTE OF NUCLEAR RESEARCH. I. CONTAINER DESIGN. Sraier, V. (Ustav Jaderneho Vyzkumu, Ceskoslovenska Akademie Ved, Rez). Mar. 1966. 24p. Dep. mn.

The extraction equipment has a capacity of 5 to 10 kg of irradiated U per day. The number of pulsed columns allows completion of one extraction cycle, for example the primary separation of U and Pu from fission products and the mutual separation of U and Pu. It can also be used for semi-pilot research on processes for dissolution of irradiated fuel elements and for extraction of solutions for testing of equipment used in processes for recovery of irradiated fuel. (J.R.D.)

33417 (ORNL-tr-1239) QUARTERLY REPORT NO. 3 [ON PHYSICAL CHEMISTRY], JULY 1–SEPTEMBER 30, 1965. (European Atomic Energy Community. Kernforschungsanlage, Juelich (West Germany)). Translated by R. G. Mansfield (Oak Ridge National Lab., Tenn.), from a report. 17p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Research is described on distribution coefficients of Am and Pm between aqueous nitric acid containing lithium nitrate and mixtures of trioctyl phosphine oxide and dodecylamine in diethylbenzene. Results of investigations are included concerning liquid scintillation counting of aqueous Am–Pm solutions in presence of salts. (J.R.D.)

33418 (ORNL-tr-1241) QUARTERLY REPORT NO. 7 [ON PHYSICAL CHEMISTRY] JULY 1–SEPTEMBER 30, 1965. (European Atomic Energy Community. Kernforschungsanlage, Juelich (West Germany)). Translated by R. G. Mansfield (Oak Ridge National Lab., Tenn.), from a report. 7p. Dep. mn. JCL $1.10 fs, $0.80 mf.

Research is described on distribution coefficients of Pm, Am, and Cm between aqueous HNO_3 and solutions of trioctylphosphine oxide and dodecylamine in cyclohexane. Discussions of similar investigations are included in which diethyl benzene diluent is used. (J.R.D.)

33419 FAST SEPARATION OF ^{95}Nb FROM ^{95}Zr IN COMMERCIAL RADIOISOTOPE SOLUTIONS. Jurriaanse, Aart; Moore, Fletcher L. (Oak Ridge National Lab., Tenn.). Anal. Chem., 38: 964-5(July 1966). (ORNL-P-2097).

A new, fast, cheap liquid–liquid extraction method for the quantitative separation of carrier-free ^{95}Nb and ^{95}Zr tracers present in commercial radioisotope solutions is described. The method is based on the highly selective extraction of ^{95}Nb tracer with diisobutylcarbinol from aqueous solutions of dilute sulfuric acid-hydrofluoric acid. The ^{95}Nb tracer may be easily stripped into a wide variety of aqueous reagents for tracer work. Radiochemical purities of >99.9% for ^{95}Nb and 99.8% for ^{95}Zr are readily achieved. (auth)

33420 PROPERTIES OF MACROPOROUS ION EXCHANGE RESINS. I. GENERALITIES; STUDY IN AQUEOUS SOLUTION. Barbier, Yves; Rosset, Robert (Ecole Superieure de Physique et de Chimie, Paris). Bull. Soc. Chim. France, No. 4, 1388-94(Apr. 1966). (In French).

Macroporous ion exchange resins are characterized by the existence in the grains of large-dimension channels, which cause a contact surface between the resin and the solution and a supplementary swelling of 0.5 cm^3/g of the dried resin with respect to resins of gel structure. In aqueous solution the properties of these resins (exchange capacity, exchange constant, form of the permutation fronts of ions by displacement) are little different from those of equivalent ordinary resins. Nevertheless, the penetration of electrolyte in the resin grains by Donnan equilibrium is more important: the capacity increases from 25 to 30% for a molar external solution whereas this increase for classical resins is only about 8%. (tr-auth)

33421 SOLVENT EXTRACTION OF NIOBIUM AND TANTALUM. II. EXTRACTION AND SEPARATION OF ZIRCONIUM AND NIOBIUM WITH DI-OCTYL-METHYLENE-BIS-PHOSPHONIC ACID. Gorican, H.; Djordjevic, C. (Inst. Ruder Boskovic, Zagreb. Univ. of Zagreb). Croat. Chem. Acta, 37: 265-75(1965).

A method for separating ^{95}Zr and ^{95}Nb by extraction with di-octyl-methylene-bis-phosphonic acid (DOMPA), $CH_2[PO(OC_8H_{17})OH]_2$ is described. Extraction behavior of these metals was studied under different conditions from sulfuric, hydrochloric, hydrofluoric, and oxalic acid solutions. The influence of these acids and reagent concentration on separation is discussed. Quantitative separation was achieved by extraction with DOMPA from mixed oxalic and sulfuric acid solutions in metal concentrations lower than 10^{-5}M, as well as on the carrier-free scale. Successful re-extraction of zirconium with hydrofluoric acids was obtained. This separation can be performed directly on commercially available tracer solutions. (auth)

33422 SEPARATION OF SMALL QUANTITIES OF ELEMENTS BY COPRECIPITATION WITH IRON HYDROXIDE. SEPARATION OF YTTRIUM, STRONTIUM, AND RUBIDIUM. Novikov, A. I.; Starovoit, I. A. Dokl. Akad. Nauk Tadzh. SSR, 8: No. 6, 25-9(1965). (In Russian).

^{90}Sr, ^{90}Y, and ^{86}Rb were separated by co-precipitation with iron hydroxide at various pH. Iron nitrate or iron chloride was added to an acid mixture of radioisotopes. Pyridine and ammonium hydroxide or potassium hydroxide were used to precipitate iron hydroxide. ^{90}Y was precipitated at pH 6 to 6.4, ^{90}Sr at 13, and ^{86}Rb remained in solution. (D.H.M.)

33423 FISSION-PRODUCT RETENTION OF DEGRADED KEROSENE WITH NITRIC ACID. Ishihara, Takehiko; Ohwada, Ken (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 3: 243-8(June 1966).

A determination of strong complexing species contained

in degradation products formed by the reaction of nitric acid on kerosene diluent was performed through: (1) observation of change in the absorbancy of nitroparaffins (at 1563 cm^{-1}), of carboxylic acids (at 1694 cm^{-1}), and of nitrate esters (at 1640 cm^{-1}) against γ activity of ^{95}Zr–^{95}Nb extracted into the degraded kerosenes; (2) separation of the main complexing species from the degraded kerosene by an acid-alkali treatment; and (3) nitration of oleic acid with nitrogen oxide gases and observation of change in its extractability for ^{95}Zr–^{95}Nb. It was conclusively established that nitroparaffins were among the main complexing species, and exhibited a strong retaining power on fission products, especially ^{95}Zr–^{95}Nb. Some possible retention mechanisms for fission products are proposed and discussed on the basis of tautomeric equilibria of nitroparaffins. (auth)

33424 RELEASE OF TRITIUM AND ^{85}Kr TO THE ATMOSPHERE DURING PROCESSING OF ThO_2–UO_2 REACTOR FUEL. Goode, J. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 21-2(June 1966).

33425 STUDIES OF THE PROPERTIES OF PLUTONIUM HEXAFLUORIDE IN THE DEVELOPMENT OF A VOLATILITY METHOD FOR NUCLEAR-FUEL REPROCESSING. Trevorrow, L. E.; Wagner, R. P.; Steindler, M. J. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 22-3(June 1966).

33426 SOLUBLE POISON FOR NUCLEAR SAFETY CONTROL DURING FUEL PROCESSING. Morrison, W. G.; Buckham, J. A.; Ayers, A. L. (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 9: 23(June 1966).

33427 REMOVAL OF ^{137}Cs FROM MOLTEN SODIUM BY MEANS OF GETTERS. McGuire, J. C. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 303-4(June 1966).

33428 STATUS OF PROCESS DEVELOPMENT FOR THORIUM-BEARING HTGR FUELS. Ferguson, D. E.; Hannaford, B. A.; Nicholson, E. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 315(June 1966).

ENGINEERING

General

33429 (TID–23117) HIGH-TEMPERATURE ENERGY SYSTEMS. Quarterly Progress Report, November 1, 1965–January 31, 1966. (Bureau of Mines, Morgantown, W. Va. Morgantown Coal Research Center). 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Runs with a Brayton cycle gas turbocompressor showed that modifications to the compressor diffuser vanes and turbine shroud eliminated surge and turbine rub. The thrust bearing of the turbocompressor is being surfaced with chromium oxide to eliminate gas leakage through the bearing and permit hydrodynamic operation. Evaluation of gas-solids suspensions as heat-transfer media was continued. Suspensions of 18 to 40 μ glass beads in inert gas at ratios up to 1.0 pound per pound of gas were circulated at velocities to 60 fps. Heat-transfer coefficients for suspensions were slightly higher than coefficients for gas alone. In an effort to measure the amount of energy that can be recovered by a turbine operating on suspensions, a single-stage, radial-inflow machine was operated on coal-air mixtures (70% through 200 mesh). The results indicate that radial-inflow turbines are not suitable for suspensions. Installation of a fluidized-bed combustor was completed. Tests with the natural-gas preheat burner showed the instrument and safety systems to work properly. (J.R.D.)

33430 (UCRL–14917) FORCE: A COMPUTER PROGRAM FOR CALCULATING MAGNETIC FORCES DEVELOPED IN ELECTROMAGNETS. Henning, Carl D. (Lawrence Radiation Lab., Univ. of California, Livermore). May 24, 1966. Contract W-7405-eng-48. 38p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The windings of an electromagnet experience mutually induced forces according to the Laws of Ampere and Faraday. Often, as in the case of large superconducting magnets, extreme forces are produced that require the design of massive structural reinforcement. This design in turn requires detailed knowledge of the force distribution. For a simple geometry such as an infinite solenoid, hand calculations can be made without much difficulty. However, when complex magnet configurations are employed, another method of magnetic force evaluation must be sought. A general computer program, FORCE, that uses the FORTRAN II Language for digital computers, was developed. (auth)

33431 (ORNL-tr–1229) STUDIES WITH STRUCTURAL MODELS CONDUCTED AT THE SERVICE OF HYDRAULIC STUDIES OF THE STUDY AND RESEARCH ADMINISTRATION OF ELECTRICITE DE FRANCE. Beaujoint, M. N. Translated for Oak Ridge National Lab., Tenn., from Ann. Inst. Tech. Batiment Trav. Publics, 14: 1220-36(1961). 38p. Dep. mn. JCL $3.60 fs, $1.34 mf.

Differences between models with elastic behavior, obeying flexible similarity conditions, and resistance models governed by stricter similarity conditions are demonstrated. One of the advantages of elastic models resides in the practical aspect. Examples of experiments conducted with rubber and with plaster models are cited. A survey of varied research especially studies of duct reinforcement in the field of construction for nuclear reactor containment is presented. (auth)

33432 CALCULATIONS ON ORTHOGONAL ELASTIC REINFORCED MAXWELL SHELLS WITH SMALL REINFORCING MEMBERS (FOR EXAMPLE, STEEL–CONCRETE SHELLS). PART II. Schoop, Heinrich (Univ., Berlin). Nucl. Eng. Design, 3: 233-45(1966). (In German).

Examples are given of the calculation of orthogonal elastic reinforced Maxwell shells. The examples considered are the rotational symmetrically charged circular cylindrical shell, jointed stacked rectangular plates, and rotational symmetrical circular ring disc with position changing parts. (J.S.R.)

33433 UNCONVENTIONAL POWER PRODUCTION ON A GIGANTIC SCALE. Mawardi, O. K. (Case Inst. of Tech., Cleveland). New York, Inst. of Electrical and Electronics Engineers, 1966, Preprint No. 31 CP 66-46, 15p., $1.00. (CONF-660108–4). ORAU.

From IEEE Winter Power Meeting, New York.

Two schemes to demonstrate the possibility of exploiting the natural potential energy of the earth to extract power in large quantities without depleting fossil fuel resources are suggested to meet the increasing power needs of the next 15 years. One scheme proposes to explode fusion-type nuclear explosions in cavities in the earth in high thermal gradient regions to reduce heat losses by convection through the earth. The second scheme is a hydromagnetic conversion scheme or ocean current generator to use the energy of the mass transport of sea water in the swift ocean currents. Calculations of the amount of energy probably available from each scheme are presented. (B.L.M.)

Applications of Nuclear Explosions

33434 (PNE–5004P) CONSTRUCTION TECHNIQUES AND COSTS FOR UNDERGROUND EMPLACEMENT OF NUCLEAR EXPLOSIVES. Samuelson, W. J.; Hair, J. L. (Army Engineer District, Fort Worth, Tex.); Fisher, P. R. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). Aug. 1965. 217p. Dep. mn. CFSTI $2.00 cy, $1.25 mn.

Equipment, methods, and cost that are considered feasible for constructing underground emplacements for nuclear explosives such as would be used in nuclear excavation are described. Discussions are included concerning the available methods and techniques being used in big hole (36-in.-dia and larger) drilling, tunneling, and conventional shafting. The technical data were collected from the literature and by personal contacts with Government agencies and private industries. Big hole drilling methods can be divided into four types: churn drilling, auger drilling, calyx drilling, and rotary drilling. Of these, auger drilling is the most economical for holes to depths of 150 ft in soft material, and rotary drilling is by far the most popular choice for depths in excess of 150 ft. Rotary drilling is not limited to any specific material type and therefore is the most adaptable method. Equipment for rotary drilling is variable but in most cases consists of "beefed-up" oil well rigs employing modified hoisting facilities. Discussions concerning mining and shafting cover the conventional cyclic method of drilling and blasting as well as the mechanical mining methods. Mechanical tunneling methods are used with much success in both soft and hard rock. New equipment has become available with emphasis being placed on increasing the thrust capabilities of the cutter heads and improving the design of the cutters. Cost analyses for big hole drilling are included along with analyses for tunneling and shafting. These costs are believed realistic for the current period and are considered adequate for making preliminary cost estimates. (auth)

33435 (UCRL–12248-T(Rev.1)) NUCLEAR EXCAVATION. A Progress Report. Nordyke, Milo D. (Lawrence Radiation Lab., Univ. of California, Livermore). Contract W-7405-eng-48. 5p. (CONF-660606–6). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Nuclear Society Meeting, Denver.

A review is presented of developments in investigations of nuclear explosives applications in industry. Applications relating to excavation, mining, and isotope production are being investigated. Information is included on single-charge cratering, row-charge cratering, and costs of nuclear devices. (J.R.D.)

33436 (UCRL–14191(Rev.1)) ARTIFICIAL AND NATURAL RADIOACTIVITY IN NUCLEAR EXCAVATION. Higgins, Gary H. (Lawrence Radiation Lab., Univ. of California, Livermore). June 2, 1965. Contract W-7405-eng-48. 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Nuclear excavation technology is briefly reviewed. Areas discussed are scaling laws, canal excavation, costs, and safety. The radioactivity resulting from nuclear excavation of a sea-level Isthmian canal is estimated and compared with natural background radiation. (auth)

33437 (UCRL–14280(Rev.2)) POST-EXPLOSION ENVIRONMENT RESULTING FROM THE SALMON EVENT. Rawson, D.; Randolph, P.; Boardman, C.; Wheeler, V. (Lawrence Radiation Lab., Univ. of California, Livermore). [1966]. Contract W-7405-eng-48. 43p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The Salmon event was a 5.3 ± 0.5 kt nuclear detonation at a depth of 827.8 m in the Tatum salt dome in Mississippi. The explosion created a nearly spherical cavity of a radius 17.4 ± 0.6 m, and vaporized and melted approximately 5.4×10^6 kg of rock which formed a puddle of recrystallized salt. At the time of penetration the cavity was under a partial vacuum with a pressure of less than 313 mb and the temperature of its gases was about 205°C. Most of the explosion energy was in the form of heat distributed within 45 m of the shot point. Radioactive melt injected into cracks was observed as far as 37 m from the shot point and radioactivity increased above background as far as 64 m. The wall rock was highly microfractured and contained some macrofractures. The most broken portion of the rock surrounding the cavity was observed in the region 39 to 50 m below shot point. The puddle at the base of the cavity was highly fractionated with a high concentration of refractory radioactive species in the bottom few centimeters. Separation of ^{131}Xe in the cavity gas from the parent ^{131}I found in the puddle indicates that the puddle took 24 to 32 days to solidify. It is concluded that the resulting cavity is stable and could be used for a decoupled or partly decoupled experiment; however, the material surrounding the cavity is less competent than the preshot condition and the strength properties and stress distribution of that rock are not known. (auth)

33438 ENGINEERING FEASIBILITY OF NUCLEAR BLASTING. Hartman, Howard L. Argonne Nat. Lab. Rev., 3: 33-40(Apr. 1966).

An evaluation of the peaceful potential of nuclear explosives for industrial and public-works purposes is presented. The economic, safety, and technologic feasibility of such a program is discussed. (B.G.D.)

33439 TRANSURANIUM ELEMENTS THROUGH NUCLEAR EXPLOSIVES. Walterscheid, Ed (Los Alamos Scientific Lab., N. Mex.). Nucl. News, 9: 16-18(July 1966).

The production of transuranium elements in underground nuclear explosions is discussed. The practicality of this idea results from the total integrated neutron flux estimated to be $1.2 \times 10^{25} N/cm^2$ from the detonation. (B.G.D.)

33440 GRADUATE-LEVEL COURSE IN NUCLEAR CIVIL ENGINEERING. Kruger, Paul (Stanford Univ., Calif.). Trans. Amer. Nucl. Soc., 9: 208(June 1966).

33441 RETORTING OIL SHALE IN A NUCLEAR CHIMNEY. Lombard, D. B. (Univ. of Calif., Livermore); Carpenter, H. C. Trans. Amer. Nucl. Soc., 9: 310(June 1966).

33442 NUCLEAR EXCAVATION: A PROGRESS REPORT. Nordyke, Milo D. (Univ. of California, Livermore). Trans. Amer. Nucl. Soc., 9: 311(June 1966).

33443 NUCLEAR STIMULATION OF NATURAL-GAS PRODUCTION. Coffer, H. F.; Aronson, H. H. (Geonuclear Corp., Las Vegas, Nev.). Trans. Amer. Nucl. Soc., 9: 311-12(June 1966).

33444 PLOWSHARE IN UNIVERSITY PROGRAMS. Talley, Wilson K. (Univ. of California, Davis). Trans. Amer. Nucl. Soc., 9: 312(June 1966).

Facilities and Equipment

Refer also to abstracts 33251 and 33599.

33445 (EGG–1183-1210) TELEVISION SYSTEM STUDY FOR ACCIDENT RECOVERY (PHASE I). Talpis, N. A.; Burge, D. L. (Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.). Apr. 1966. Contract AT(29-1)-1183. 196p. (IDO–10047). Dep. mn. CFSTI $5.00 cy, $1.00 mn.

A previous study indicated a need for a portable television system capable of operating in hazardous environments during recovery operations. A system to accomplish this is described and justified. Four television cameras will be used for coverage, with three radiation-tolerant and environmental-resistant cameras to be used in and around the source, and one standard environmental-resistant camera to be used for general area surveillance. All cameras will be controlled at a remote control monitor console located up to 2100 feet from the cameras. Further separation from the camera control units of from five to ten miles is possible through the use of lightweight, portable, one-way microwave systems. The standard camera may be used, hand-held, aboard airborne platforms and linked to the monitors by microwave. An intercom system will provide communications between wire-connected cameras and control area. Monitor viewing is provided for use at the camera, if necessary, and at the control area. A three-dimensional viewing adapter will permit the utilization of two radiation-tolerant cameras in a configuration that will provide a depth perception viewing capability. A video and audio tape recorder, plus still and motion picture cameras will be available for recording of scenes and intercom channel for realtime viewing or data storage. A vehicle is proposed to allow remote camera positioning from the control area, thereby eliminating the need for personnel in the hazardous environment. Design criteria, final system design and equipment lists are included. (auth)

33446 (K-M-6013) PREVENTION OF "ON-STREAM" FAILURE OF COOLING TOWER FAN BLADES. Ellis, J. M.; Taylor, W. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). June 15, 1966. Contract W-7405-eng-26. 8p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

In-place inspection of cooling tower fan blades to prevent "on-stream" failure is discussed. The visible dye penetrant method was chosen for the inspection. (M.C.G.)

33447 (Y-EF–10) TESTING HIGH-EFFICIENCY FILTERS. Little, J. C. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). June 10, 1966. Contract W-7405-eng-26. 37p. (CONF-660617–1). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From American Assn. for Contamination Control Conference, Boston.

The photometer method, using dioctyl phthalate (DOP), of testing for leaks in high-efficiency air filtration systems offers a fast and dependable means of obtaining a dust-tight filter system. It was concluded that prior to installation, the final high-efficiency filters should be tested for total DOP penetration at both 100 and 20% of the rated capacity. After installation, the complete final filter assembly should be carefully leak tested with DOP The design of the final filter holding system should be of all-welded, air-tight construction. A design of rigid angle iron, with eight hold-down pressure points per filter, proved to be very satisfactory in obtaining very high overall system efficiencies. (auth)

33448 MACHINE FOR THE REMOVAL OF IRRADIATED NUCLEAR FUEL CARTRIDGES FROM THEIR CASINGS. Guiloteau, Rene (to Commissariat a l'Energie Atomique). German Patent 1,213,931. Apr. 7, 1966. Priority date Apr. 15, 1960, France.

A machine for extracting irradiated cartridges of nuclear fuel from their casings comprises two assemblies, each provided with means for receiving and clamping a casing by its opposite ends in a substantially horizontal position, the casing containing at least one cartridge,

means for exerting a longitudinal traction force on the casing, a cutting head arranged between the assemblies for subdividing the casing into two parts, and means for swinging each of the receiving and clamping means and the resultant half-casings carried thereby into a position in which the open ends of the half casings are downwardly directed. (Gmelin Inst.)

33449 APPARATUS FOR MOVING A RADIOACTIVE SOURCE BETWEEN EXPOSURE AND SAFE POSITIONS. Peterson, Oscar A. (to Halcon International, Inc.). U. S. Patent 3,254,224. May 31, 1966. Filed July 18, 1962.

An apparatus for holding a radioactive source such as ^{60}Co deep within a mass of shielding material in a nonrotatable manner includes a bore through the shielding material adapted to hold an actuating rod to which is attached the source and another bore at right angles to the first for positioning the source outside the shielding material. The bore at right angles to the first is provided with a plug to ensure shielding conditions when the source is not in use. Means are provided for moving the actuating rod so that the source may be positioned in the center of the shielding material or outside the shielding material when in use. (B.L.M.)

Heat Transfer and Fluid Flow

See also PHYSICS — Fluid Physics and Thermodynamics

Refer also to abstracts 33869, 34878, and 34893.

33450 (CONF-651026, pp 357-88) HIGH PERFORMANCE "ONCE-THROUGH" BOILING OF POTASSIUM IN SINGLE TUBES. Peterson, J. R. (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section).

Boiling potassium heat transfer results obtained in a two-fluid Haynes-25 alloy facility are presented. The single-tube test section used is a shell and tube heat exchanger, approximately eight feet long, in which boiling potassium in the tube is heated by sodium flowing in the annulus. Boiler tubes of 0.92-inch and 0.67-inch inside diameter were tested, both with and without instrumented vortex generator inserts. Boiling heat transfer and pressure loss data were obtained from 10% quality to over 200°F of vapor superheat at the test section exit at boiler exit temperatures from 1500 to 1750°F at average heat fluxes up to about 200,000 Btu/hr-ft^2. The heat transfer data presented include "overall" performance, "average" heat transfer coefficients, critical heat flux determinations, and local transition boiling heat transfer coefficients. (auth)

33451 (CONF-651026, pp 553-81) AN EXPERIMENTAL STUDY OF THE CONDENSING CHARACTERISTICS OF MERCURY VAPOR FLOWING IN SINGLE TUBES. Albers, James A.; Namkoong, David Jr. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

An investigation was conducted to determine the condensing characteristics of mercury vapor flowing in horizontal single tubes. For a crossflow-nitrogen-cooled condenser, flow regime and pressure drop were investigated for nonwetted flow in constant diameter and tapered tubes, under 1 and 0 g, and for wetted flow in tapered tubes under 1 g. For a counterflow-NaK-cooled condenser, heat transfer, inlet pressure, and pressure drop were investigated for a tapered tube under 1 g. Within the limits of the investigation and predicated on SNAP-8 requirements, the results obtained from the nitrogen-cooled condenser indicated no significant influence of gravity on nonwetted condensing pressure drop. Wetted 1-g condensing frictional pressure drop was higher than that of nonwetted only at the higher flow rates in a tapered tube. Data compared with the Lockhart-Martinelli and fog-flow correlations showed deviation from the former and data scatter on the latter. For the conditions investigated, the NaK-cooled condenser indicated that the mercury condensing coefficients were higher than the NaK heat-transfer coefficient; therefore the NaK side was the more significant factor affecting the overall heat transfer coefficient. The inlet pressure of mercury, which is intimately related to the mercury inlet temperature and therefore to the heat-transfer mechanism of the condenser, was found to be sensitive to condensing length at shorter condensing lengths and insensitive at the longer condensing lengths. (auth)

33452 (CONF-651026, pp 669-93) THERMAL AND FLUID DYNAMIC PERFORMANCE OF POTASSIUM DURING CONDENSATION INSIDE A TUBE. Sawochka, S. G. (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section).

Forced convection heat transfer and pressure change data for the condensation of potassium inside a vertical tube are presented and discussed. These data, obtained at saturation temperatures up to 1400°F and heat fluxes up to 3(10^5) Btu/hr-ft^2, provide a reasonable basis for the thermal design of potassium space power system condensers. A comparison of analytical and measured fluid temperature profiles is given which indicates that estimation of local potassium temperatures from measured condenser inlet and outlet temperatures is of questionable accuracy for calculation of reliable condensing heat transfer coefficients. The response of the test condenser to a change in location of the liquid-vapor interface is discussed. (auth)

33453 (DP–1013) EFFECT OF SPACING ON HEAT TRANSFER BURNOUT IN ROD BUNDLES. Towell, R. H. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 1965. Contract AT(07-2)-1. 21p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The burnout heat flux for boiling light water in a mockup of the central cooling channel of a multirod fuel bundle did not change appreciably when the space between the rods was decreased to as little as 0.018 inch. Burnout heat fluxes measured with forced boiling flow were twice the values reported for some multirod test sections with comparable rod spacings (0.015 to 0.050 inch) and about 50% higher than values reported for larger rod spacings (>0.070 inch). The higher heat fluxes are attributed to the relatively uniform cooling that was obtained in the mockup by use of a single coolant channel of a symmetrical shape. Such high heat fluxes probably cannot be duplicated in rod bundles that have nonuniform coolant channels. (auth)

33454 (EUR–2775.d) BAU EINER APPARATUR ZUR BESTIMMUNG DER WAERMELEITFAEHIGKEIT VON HARTKOHLE (KOHLESTEIN) UNTER GASATMOSPHAERE IM DRUCKBEREICH VON 0 - 15 ATUE UND BEI TEMPERATUREN BIS 250 DEG C. (Construction of Apparatus for Determination of Thermal Conductivity of Coal Stones in Gas at Pressures in the 0-15 Atmosphere Range and at Temperatures up to 250 deg C). Langen, J.; Hecker, R. (Brown, Boveri/Krupp Reaktorbau G.m.b.H.; Duesseldorf (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1966. 20p. Dep. mn.

An interesting building material for high-temperature reactors are the so-called coal stones. The thermal conductivity of these articles mainly depends on their ingredients, process of manufacturing and because of the high porosity on reactor conditions such as gas properties, gas pressure, and temperature. A test box was constructed and built in form of a double walled water-cooled steel cylinder with an ID of 130 mm. A cylindrical coal stone bar was applied as sample which was heated by a central situated heating bar. The sample was 60 mm in dia and 200 mm long. At various radii, holes were made parallel to the main axis to put in thermocouples to measure temperatures. A formula is given for thermal conductivity calculation. (J.R.D.)

33455 (EUR–2982.e) CONVERSION OF LEAK FLOW-RATES FOR VARIOUS FLUIDS AND DIFFERENT PRESSURE CONDITIONS. Amesz, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 30p. Dep. mn.

The development of rules for conversion of gas and liquid leakages is presented. In many cases, for reasons of convenience, leaktightness of components is tested by means of

a gaseous medium, although they actually operate with a liquid medium. As leak mechanisms of a liquid and a gas are often principally different, conversion requires the application of appropriate correlations. Based on theoretical considerations, such correlations are derived and presented. (auth)

33456 (EURAEC–1398) THE STEADY-STATE AND DYNAMIC BEHAVIOUR OF A BOILING WATER REACTOR. Quarterly Progress Report No. 16, October 1, 1964–January 1, 1965. (Technische Hogeschool, Eindhoven (Netherlands)). Jan. 1965. Contract P-313. 16p. (EUR–2357; WWO-16-R79). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

A physical burnout occurred due to wrong switching off of the power. Upon checking the damage of the shroud following this incident, the impedance void gauges appeared to be seriously corroded. New void gauges consisting of teflon with silver electrode plates were constructed and mounted in the shroud. The passage of the leads from the void gauges in the pressure vessel gave troubles as the insulation of the wires in this passage were damaged. A new flange was constructed. The influence of the earth potential of the shroud on the electrical field between the impedance void gauges and the heating element appeared to be greater than was expected before. The shroud had to be insulated from the pressure vessel. An irregularly varying indication of the void meters was attributed to bad centering of the heating element inside the shroud. Measurements were carried out at 160°C. The variation resistance with time in the one phase region as measured by the impedance gauges appeared to be dependent on the geometry of these gauges. A void gauge consisting of 3 parallel plates placed at the bottom of the downcomer was used as a reference for the electrical resistance of the water. This method does not satisfy. The geometry of this reference gauge must be the same as that of the void gauge. (auth)

33457 (NAA-SR-Memo–11858) A SYSTEMATIC CORRELATION FOR TWO-PHASE PRESSURE DROP. Baroczy, C. J. (Atomics International, Canoga Park, Calif.). Mar. 11, 1966. Contract AT-11-1-GEN-8. 61p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

A correlation which considers fluid properties, mixture quality, and mass velocity is described for the prediction of two-phase friction pressure drop for both single and two-component flow. The correlation is based on data for steam, water-air, and mercury-nitrogen for a wide range of quality and mass velocity. The two-phase friction multiplier is shown to be a function of liquid to gas viscosity and density ratios (a property index), mixture quality, and mass velocity, for the following ranges: property index, critical point to five decades below; quality, 0.1% to 100%; mass velocity, 0.25×10^6 to 3×10^6 lb/hr-sq ft. Comparison of the correlation with additional data for water-air, steam, sodium potassium-nitrogen, kerosene-air, diesel oil-air, and potassium, showed good agreement. (auth)

33458 (NP–16128) ON THE HYDRAULIC CHARACTERISTICS OF A BOILING WATER CHANNEL WITH NATURAL CIRCULATION. Spigt, Cornelis Ludovicus (Technische Hogeschool, Eindhoven (Netherlands)). 1966. 157p. Dep. mn.

Thesis.

The results of an experimental and theoretical study are reported on the hydraulic characteristics of a single coolant channel of simple annular geometry in a boiling water nuclear reactor, with the main emphasis on the stability characteristics of the flow process in such a channel. A description is presented of the pressurized and atmospheric boiling water loops, the two test sections and the power supply. After that, a review is given of the measuring, recording and analyzing equipment. Special attention was paid to the measurement of the void fraction in a two-phase system under steady as well as under transient conditions. The results obtained by the two methods used, e.g., the γ-ray attenuation method and the impedance method, are compared and good agreement is reported. In the description of the analyzing equipment attention was paid to the noise-analysis technique. The analysis of the boiling noise in terms of spectral power density and autocorrelation was used in determining the onset of hydraulic instabilities. Autocorrelation, cross-correlation and noise rejection techniques were used to characterize the severe flow oscillations and to express the stability of the steady state in terms of transfer functions. In the analysis of the signals use was made of digital as well as analogue computers. In the presentation of the results obtained in steady states, the influence of channel power, system pressure, subcooling and hydraulic diameter is shown on the recirculation flow rate, the exit void fraction and longitudinal void and pressure distribution. An analysis was made in terms of the Slip Ratio, S, and the Two-Phase Friction Multiplier, R. The void fraction and the two-phase friction loss data were plotted as a function of the Martinelli and Nelson correlator. Besides, the void fraction data were plotted in the "weighted mean velocity-average volumetric flux density" plane proposed by Zuber and Findlay. From this plot it may be deduced that flat profiles for the velocity or concentration distribution are present under the operating conditions reported. During operation, it was possible to distinguish between three types of flow oscillations with frequencies of roughly .03, 1 and 15 c.p.s. Systematic research was carried out as regards the 1 c.p.s. flow oscillations only. After accepting a criterion for defining the onset of the hydraulic oscillations, the influence of system pressure, subcooling and hydraulic diameter on the instability threshold channel power was systematically examined. It was found that the effect of increased subcooling upon the onset of severe hydraulic oscillations at low subcooling rates was opposite to that at high subcooling rates. The character of these oscillations has been studied by making recordings during hydraulic oscillations of the relevant physical quantities, such as, for instance, the void fraction along the height, the inlet mass flow, etc. Results of transfer function measurements from channel power to inlet mass flow and local void fraction are presented. Characteristic for all these transfer functions was the occurrence of a sharp resonance peak when the instability threshold was approached. It is shown that there exists a relationship between the character of the transfer function and the onset of spontaneous flow oscillations. The influence upon the two of the operating conditions is similar. Burn-out channel powers and heat fluxes are presented for various values of system pressure and subcooling. Nearly all the burn-outs were obtained under unstable flow conditions. The general equations are derived describing the performance characteristics of a boiling system under steady-state and non-steady state conditions. Special attention was paid to the formulation of the boundary conditions and the introduction of pressure effects into the equations. The significant differences of the approach as compared with the theoretical models of others are indicated. The dynamic equations were linearized by assuming small disturbances from the steady state. Furthermore, by applying an open-loop analysis, stability criteria were derived for detecting the onset of flow oscillations in natural as well as forced circulation boiling systems. The equations were numerically integrated by means of a digital computer. Preliminary results of calculations were reported for the operating and geometry conditions as considered in the experimental program. Fairly good agreement was obtained between theoretically and experimentally obtained quantities of the steady-state performance, the instability threshold power and the character of the hydraulic oscillations. (auth)

33459 (ORNL-TM–1413) VAPOR-BUBBLE-GROWTH RATES IN SUPERHEATED LIQUID METALS. Wichner, R. P.; Hoffman, H. W. (Oak Ridge National Lab., Tenn.). July 1966. Contract W-7405-eng-26. 37p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The rate of growth of a vapor bubble in a superheated liquid-metal is derived under the assumption that the liquid temperature remains constant at the equilibrium value required for an arbitrary initial bubble size. Bubble growth results from the disturbance of this equilibrium

by the Stokes rise and is limited only by the mass inertia of the displaced liquid. The effects of surface tension and of liquid pressure variation as the bubble rises in the pool are taken into account. A single, dimensionless parameter is found which specifies both the superheat conditions and the bubble rise velocity. Superheats required for pool-boiling K are calculated for a range of initial bubble sizes, pool overpressures, and pool depths. The superheat was found to increase both with decreasing initial bubble size and with decreasing overpressure but was relatively uninfluenced by pool depth. A high rate of energy increase found in the growing bubbles suggests that heat conduction in the liquid K may have a role in specifying the bubble-growth rate. Further, since the bubble-growth rates far exceed the bubble rise velocity, the shape of a bubble born on the bottom surface of the pool tends to distort from the original spherical shape. (auth)

33460 (STL-372-14(2)(Vol.2)) HYDRODYNAMIC STABILITY OF NATURAL CIRCULATION BOILING SYSTEM. VOLUME II. COMPUTER PROGRAM DESCRIPTIONS. Cho, E.; Elwell, J.; Jepson, P.; Sprankle, M. (TRW Systems, Redondo Beach, Calif.). June 30, 1965. Contract AT(04-3)-372. 238p. Dep. mn. CFSTI $6.00 cy, $1.25 mn.

The partial differential equations for a boiling channel are written in Lagrangian form, linearized, and the transfer function (frequency response) derived. The model is simplified by neglecting slip between the phases and by assuming the loop pressure drop is concentrated at the channel exit. Stability is examined using the Nyquist criterion. The computer program produces the locus of the feedback transfer function for an arbitrary number of specified frequencies. (auth)

33461 INFLUENCE OF THE RADIAL DEPRESSION OF HEAT GENERATION IN TEMPERATURE CALCULATIONS FOR CYLINDRICAL FUEL RODS CONSISTING OF METALLIC URANIUM, URANIUM DIOXIDE, AND URANIUM CARBIDE. Johannsen, K. (Technische Univ., Berlin). Atomkernenergie, 11: 270-2(July-Aug. 1966). (In German).

The influence of the radial depression of heat generation on the temperature drop in cylindrical fuel rods consisting of metallic uranium, uranium dioxide, and uranium carbide was calculated. The results are plotted against fuel enrichment for different fuel radii. (auth)

33462 INFLUENCE OF THE HYDRODYNAMIC CONDITIONS ON THE CRITICAL LOADING OF THE HEATING SURFACE DURING BOILING. Mayinger, F.; Schad, O.; Weiss, E. Brennstoff-Waerme-Kraft, 18: 288-94(June 1966). (In German).

In measurements of the critical loading of heating surfaces during boiling in channels with forced flow two different types of burnout were observed: in the first type—the pulsating burnout—fluctuations in pressure and flow rate occur shortly before the moment of burnout; the second type exhibits hydrodynamically stable behavior until suddenly film boiling sets in. In the case of pulsating burnout, observed only in the range of supercooled boiling, the critical loading of the heating surfaces was 20 to 50% below the respective value for the hydrodynamically stable flow. (auth)

33463 INTERPRETATION OF THE DEGRADED HEAT TRANSFER DURING FILM EVAPORATION IN VERTICAL FLOW CHANNELS. Zwickler, Reinhold (Deutsche Babcock and Wilcox-Dampfkessel-Werke AG, Oberhausen, Ger.). Brennstoff-Waerme-Kraft, 18: 295-300(June 1966). (In German).

During film evaporation in vertical pipes a laminar steam boundary layer forms between the heating surface and the liquid, leading to a decrease in the heat transfer coefficient α, which passes through a minimum in the direction of the flow. By calculating the Reynolds number of the boundary layer at the minimum point it is shown that an improvement of the heat transfer on reaching the α_{min} value can be explained by changeover in the boundary layer of the flow from laminar to turbulent form. (auth)

33464 HEAT TRANSFER DURING INJECTION OF A BOILING INTO A HOTTER NON-BOILING FLUID. Schnitker, Werner (Internationale Atomreaktorbau GmbH, Bensberg, Ger.). Brennstoff-Waerme-Kraft, 18: 301-6 (June 1966). (In German).

An experimental investigation was performed of the pressure changes in a tank which is completely filled with terphenyl and into which water penetrates from above a fluid mixture can escape. If the water evaporates partially in the terphenyl and in addition absorbs heat from it, the heat transfer plays an important role in the development of the pressure. An equation is given for the heat transfer. It follows from this equation that the pressure does not decrease appreciably if the cross section of the escape pipe is made larger because such an enlargement causes an increase in the volume of the two-phase mixture and consequently an increase in the heat transfer. Only when superheated steam forms does such an enlargement have an increased effect, but the resulting pipe diameters are too large for practical realization. (auth)

33465 TEMPERATURE DISTRIBUTION AND EFFICIENCY OF A PLATE AND ANNULAR FIN WITH CONSTANT THICKNESS. Okamoto, Yoshizo (Japan Atomic Energy Research Inst., Ibaraki). Bull. JSME (Jap. Soc. Mech. Eng.), 9: 143-50(Feb. 1966).

A theoretical analysis is given of heat transfer by convective and radiative fins on heat exchangers, space radiators, or nuclear fuel elements at high temperature, particularly for thick fins which emit radiation and convection energy to an enclosing gas. An analysis of thick plate and annular fin conditions is made. Two-dimensional temperature distribution and efficiency of the thick fins are solved by digital computer. The numerical solution for the net-convective and net-radiative plate fin is presented, and the relation between the efficiency of the thick fin and that of the thin fin is discussed. For the case where the thickness-to-height ratio is larger than one-third, the temperature distribution in the fin becomes two-dimensional. The efficiency of the thick fin becomes smaller with an increase in the half-thickness-to-height ratio, because the contraction effect of the heat flow causes a large temperature drop through the fin root. The efficiency is affected by the non-uniform temperature distribution across the fin-root. (BBB)

33466 ORGANIC COOLANT PERFORMANCE IN REACTOR LOOPS. Finlay, B. A.; Smee, J. L.; Hatcher, S. R. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Trans. Amer. Nucl. Soc., 9: 44(June 1966).

33467 ACCELERATION OF THE CONVERGENCE OF SUCCESSIVE OVER-RELAXATION BY ORDER OF MESH-POINT SCANNING IN THE SOLUTION OF THE DIFFUSION EQUATION FOR TRANSIENT HEAT TRANSFER. Cudahy, G. F. (Holloman Air Force Base, N. Mex.); Kaplan, Bernard. Trans. Amer. Nucl. Soc., 9: 203-4(June 1966).

33468 MOMENTUM FLUX MEASUREMENTS AND ENTRAINMENT IN A BOILING CHANNEL. Firstenberg, A.; Neal, L. G. (TRW Systems, Redondo Beach, Calif.). Trans. Amer. Nucl. Soc., 9: 286-7(June 1966).

33469 GENERALIZED LOCAL BOILING VOID MODEL. Sha, William T. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 287-8(June 1966).

33470 CRUCIAL BOILING LENGTH. Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 288(June 1966).

33471 SEMITHEORETICAL EQUATION FOR PREDICTING BURNOUT FOR SINGLE-ROD AND FOR MULTI-ROD EXPERIMENTS. Nicholas, Charles R. (Hydrospace Research Corp., Rockville, Md.). Trans. Amer. Nucl. Soc., 9: 288-9(June 1966).

33472 ANALYTIC STUDY OF THE TRANSIENT BOILING OF SODIUM IN REACTOR COOLANT CHANNELS. MacFarlane, D. R. (Argonne National Lab., Ill.); Brittan, R. O.; Sesonske, A. Trans. Amer. Nucl. Soc., 9: 289-90(June 1966).

33473 CHOKED-FLOW ANALOGY FOR VERY LOW QUALITY TWO-PHASE FLOWS. Hammitt, F. G.; Robinson, M. J. (Univ. of Michigan, Ann Arbor). Trans. Amer. Nucl. Soc., 9: 290-2(June 1966).

Materials Testing

33474 (BNWL-SA-594) PREPARATION OF IRRADIATED SPECIMENS TO RETAIN EDGES FOR EXAMINATION OF THIN SURFACE COATINGS. Gruber, W. J.; Smith, F. M.; Watts, E. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 18, 1966. Contract AT (45-1)-1830. 5p. (CONF-660518-3). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From AEC Annual Metallography Meeting, Denver.

A procedure, which is adaptable for remote preparation of irradiated materials, is described for mounting and preparing specimens to retain edges. Using this procedure, surface oxide layers less than 0.0001-inch thick were resolved. (auth)

33475 (SC-4452D(M)) SANDIA CORPORATION STANDARD ENVIRONMENTAL TEST METHODS. (Sandia Corp., Albuquerque, N. Mex.). June 1966. Contract AT(29-1)-789. 105p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Supersedes SC-4452C(M).

Requirements in the form of Process Standards covering the instrumentation, equipment and methods to be used in conducting environmental tests on components are presented. General guidance is included to help design, development, and test personnel achieve uniformity of testing. A check list for preparation of the environmental testing portion of product specifications is also included to promote uniformity. (B.G.D.)

33476 CONTINUOUS MEASUREMENTS OF THE THICKNESS OF THIN-WALLED TUBES OF A ZIRCONIUM ALLOY USING THE TRANSMISSION TECHNIQUE. Winkel, R. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 9: 104-6(Mar. 1966). (In German).

A technique for the measurement of the wall thickness of thin-walled tubes by beta transmission is described. The construction of the test installation is discussed and the experimental conditions are given. Measurement results are evaluated. A measurement accuracy of approximately ±5% of the tolerance limits was obtained from the tolerance range. (J.S.R.)

33477 ALPHA AUTORADIOGRAPHY: TECHNIQUE FOR EXAMINING IRRADIATED FUEL MATERIAL. Darmitzel, R. W.; Davies, J. H.; Smith, R. E. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 9: 64-5(June 1966).

Protective Structures

Refer also to abstract 34801.

Space Propulsion

See also ISOTOPE TECHNOLOGY — Power Application
REACTOR TECHNOLOGY — Propulsion and Space

Refer also to abstract 35128.

33478 (CONF-651026) AIAA SPECIALISTS CONFERENCE ON RANKINE SPACE POWER SYSTEMS, NASA LEWIS RESEARCH CENTER, CLEVELAND, OHIO, OCTOBER 26-28, 1965. VOLUME I. (American Inst. of Aeronautics and Astronautics). 768p. Dep. mn. CFSTI $8.00 cy, $3.00 mn.

Separate abstracts were prepared for 23 of the 26 included papers. For abstracts of the remaining papers see CONF 651026 in the report number index. (M.O.W.)

For abstracts of individual papers see: 33450–33452, 33479–33490, and 35112–35119.

33479 (CONF-651026, pp 3-51) MERCURY RANKINE PROGRAM DEVELOPMENT STATUS AND MULTIPLE SYSTEM APPLICATION. Wallerstedt, R. L.; Miller, D. B. (Atomics International, Canoga Park, Calif.).

The Mercury Rankine (MR) space power conversion concept has arrived at the threshold of utilization as a working spacecraft subsystem. Component and system feasibility was verified and the program is now in a reliability improvement phase. The rotating machinery and other prime computers have demonstrated greater than 3000 hr life with a relatively high degree of reliability. Development emphasis was shifted to verifying the expected life to 10,000 hr. System characteristics such as design point performance, startup, thermal interactions, structural responses, etc. were analyzed and verified in a comprehensive system test program. System design for applications has developed the multiple power conversion concept to increase the electrical output and reliability from 3 to 40 kw(e). Multiple 3- to 5-kw(e) power conversion subsystems are combined to provide any power level or degree of redundancy in that range. Potential missions were studied and the resulting criteria introduced into the requirements as applicable to a general development program. (auth)

33480 (CONF-651026, pp 52-102) MERCURY RANKINE PROGRAM SYSTEM TEST EXPERIENCE. Gresho, P. M.; Poucher, F. W.; Wimberly, F. C. (Atomics International, Canoga Park, Calif.).

Considerable test experience (over 2300 hours) was accumulated at Atomics International in the area of complete Mercury Rankine systems. This testing included a space-configured system operating in a vacuum chamber, a structural mockup system for vibration testing, and a system designed to simulate the effects of zero gravity condensing. Each of these system tests had contributed significantly toward a better understanding of the operation of a Mercury Rankine system and the combination of systems has demonstrated the feasibility of ground startup, launch survival, simulated orbital startup, and simulated steady-state operation in space. The basic objectives and overall accomplishments of these systems are discussed, the experience gained in test operations is presented, and the significant test results are summarized and discussed. (auth)

33481 (CONF-651026, pp 201-21) ELECTROMAGNETIC PUMPS FOR SPACE POWER SYSTEMS. Rhudy, R. G.; Verkamp, J. P. (General Electric Co., [Cincinnati, Ohio]).

A broad appraisal was made of the suitability of electromagnetic (EM) pumps for space power application. A general expression for EM pump efficiency is developed in terms of pump design parameters, fluid properties, and frequency of the power utilized. Although approximate, this expression applies to a wide variety of pump types. It is used to indicate parameter ranges promising for the design of pumps of high efficiency. Based on preliminary designs for space power application, performance characteristics and weight of EM pumps of several types are tabulated. The weights of these and other preliminary pump designs for space power application are compared to those of EM pumps which have operated satisfactorily in service. A specific pump design for space power application is described in detail. EM pumps presently operating with high reliability in facility service are discussed. It is concluded that, in EM pumps designed for space power application, it is feasible to achieve pump weights an order of magnitude less than those of contemporary facility pumps for similar hydraulic requirements. Potential reliability is excellent. (auth)

33482 (CONF-651026, pp 222-57) THE DEVELOPMENT OF THE MRP THERMOELECTRIC NaK PUMP. Hanlin, Harry H.; Hochman, Jack M.; Perlow, Milton A. (Atomics International, Canoga Park, Calif.).

A thermoelectromagnetic pump was developed to circulate the heat transfer fluid in a Rankine cycle, space power system. This device combines a dc conduction pump and thermoelectric generator into a single, all-metallic unit. The thermoelectric elements, chromel and constantan, extract heat from the fluid being pumped, convert a portion of it directly into electricity to supply the conduction pump, and reject the waste heat to the secondary working fluid, mercury, as it enters the boiler. This pump type offered the major advantages of no moving parts and complete sealing of the liquid metals for highest reliability and complete utilization of rejected heat for highest system efficiency. The design performance objective of 1 psi, 12 gpm NaK-78 at 1200°F was achieved and an endurance run to 6000 hours was demonstrated. Included is a description of the complete development program, detailing the design method and equations, laboratory procedures, and all important test results. (auth)

33483 (CONF-651026, pp 307-26) EFFECTS OF OIL CONTAMINATION ON HEAT TRANSFER PERFORMANCE OF FORCED-CONVECTION MERCURY BOILERS. Carey, R. S. (Aerojet-General Corp., Azusa, Calif.); Farwell, B. E. (Aerojet-General Nucleonics, San Ramon, Calif.); Thur, G. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

The major requirements associated with mercury once-through boilers for space powerplants are repeatable startup and reliable long-term heat-transfer performance without deleterious effects on other system components such as turbines, pumps, and condensers. During the past few years, there was a number of instances where mercury boilers were known to decondition either during startup or after some period of operation. The connotation is that any performance in the direction of providing poorer heat-transfer performance than expected from either design correlations or some minimum accepted performance is termed deconditioning, while any trend providing improved performance after initial thermal equilibrium is termed conditioning. This performance uncertainty during system startup and endurance operation can prevent adequate startup, cause turbine corrosion/erosion and reduce system power. Recent tests were performed in Corrosion Loop 4 single-tube boiler at Aerojet-General Nucleonics, San Ramon, California to investigate the effect on boiler performance of the SNAP-8 lubricant-coolant, mix-4P3E, when mixed with the boiler mercury. This was considered necessary since the SNAP-8 turbine-alternator assembly and the mercury pump-motor assembly use dynamic space seals that allow interdiffusion between the mercury and oil during startup and endurance operation. The experimental data from the CL-4 single-tube boiler tests were evaluated to determine the conditioning rates for various velocities in the boiler preheat region after the boiler was deconditioned by injection of mix-4P3E into the mercury loop. (auth)

33484 (CONF-651026, pp 327-56) MULTIPLE-TUBE POTASSIUM BOILER PERFORMANCE. Boppart, J. A. (Garrett Corp., Phoenix, Ariz. AiResearch Mfg. Div.); Parker, K. O.; Berenson, P. J. (Garrett Corp., Los Angeles, Calif. AiResearch Mfg. Div.).

Performance testing of a multiple-tube, sodium-heated potassium boiler was completed as the latest step in a program to develop boilers for potassium Rankine-cycle space power systems. The test boiler contained 19 tubes, with inlet orifices for flow stability and twisted-tape inserts to improve two-phase heat transfer. Test results indicated stable operation over a wide temperature range and at output vapor qualities from 40 percent to 150°F superheat. Performance confirmed predictions at high flows and high exit quality, but was lower than expected at partial flow and low exit quality. The test results along with equipment descriptions are presented. (auth)

33485 (CONF-651026, pp 391-414) 1.5 kw_e ORGANIC RANKINE CYCLE COMBINED ROTATING UNIT. Malohn, Donald A. (Sundstrand Aviation-Denver, Colo.).

The 1.5 kw organic Rankine cycle combined rotating unit (CRU) consists of a single stage partial admission impulse turbine, main alternator, speed control alternator, and working fluid pump on an integral shaft supported on hydrodynamic tilting pad bearings. An opposing pair of tilting pad thrust bearings are used to control the shaft axial location. The cycle working fluid is used as the bearing lubricant. The working fluid pump is of the pitot type. The organic working fluid used in this Rankine cycle is Dowtherm "A," a utectic mixture of Biphenyl and Biphenyl Oxide. The alternators are of the radial gap homopolar type and produce 3-phase, 3200 cycle power. Power level of the CRU can be varied by changing the size and number of nozzles used. This unit was designed, fabricated, and was tested in excess of 2,000 hours total cumulative test time. A single set of bearings installed in the CRU has operated in excess of 600 hours, cumulative running time, and was subjected to in the excess of 100 start-stop cycles. Associated turbine performance testing has indicated good agreement between test results and analytical predictions. (auth)

33486 (CONF-651026, pp 498-520) POTASSIUM TURBINE-GENERATOR DEVELOPMENT. Dannan, J. H.; Chadbourne, L. E. (Garrett Corp., Phoenix, Ariz. AiResearch Mfg. Div.).

A description of the design of a 300-kw high-temperature potassium turbogenerator is given, including representative results obtained from tests of critical turbine and bearing components. Of particular significance are the bearing development tests leading to the selection of hydrodynamic pivoted-pad journal bearings selected for the initial development turbine. The successful development of a high-temperature potassium turbogenerator is expected to provide a technology for the design and construction of high-temperature power plants satisfying special requirements for space and ground applications. (auth)

33487 (CONF-651026, pp 521-46) PERFORMANCE TEST OF A TWO-STAGE, 200-HORSE-POWER TURBINE IN WET POTASSIUM VAPOR. Rossbach, R. J.; Schnetzer, E.; Nichols, H. E.; Eckard, S. E. (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section).

An investigation was made to design, fabricate, and test a two-stage, 200-horsepower turbine for operation on potassium at inlet vapor temperature up to 1600°F. The two stages represent stages 3 and 4 in a 5-stage, 500-kw turbine for the generation of electrical power during long-time duration space missions. The turbine was fabricated from nickel, iron, and cobalt base alloys. One major objective was verification of a performance calculation method. Therefore, an overhung arrangement was selected with an oil-lubricated pivoted-pad bearing and a duplex ball-thrust bearing for turbine support. A combination argon buffer and potassium hydrodynamic seal was developed to separate the oil and potassium. The 316-type stainless steel facility having a 3000-KW gas-fired boiler has made it possible to test the turbine over a range of temperatures, speeds, and pressure ratios. The turbine blading was designed making liberal use of steam turbine technology. The off-design performance of the turbine was estimated using the characteristics of this blading. Performance data was obtained at two inlet temperature levels, namely, 1550 and 1450°F and over total-to-static pressure-ratio and speed ranges of 1.4 to 4.4 and 15,400 to 20,000 rpm, respectively. The power output data obtained agreed within 5.8 KW (The measured power output at design speed and pressure ratio was 160 KW at 1550°F inlet temperature.) of the calculated performance, demonstrating ability to calculate performance within practical limits. Individual data points were repeatable within 6 KW, indicating consistency in setting data points with reasonable tolerances and consistency in all pertinent instrumentation readings. (auth)

33488 (CONF-651026, pp 694-715) POTASSIUM CONDENSING TESTS OF HORIZONTAL MULTITUBE CONVECTIVE AND RADIATIVE CONDENSERS OPERATING AT VAPOR TEMPERATURES OF 1250 TO 1500 DEG F. Gutierrez, O. A.; Sekas, N. J.; Acker, L. W.; Fenn, D. B. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

Two types of horizontally oriented multitube vapor condensers, dissipating heat loads up to 150 KW thermal, were tested over a range of vapor temperatures from 1250° to 1500°F. One condenser was a 7-tube counterflow shell-and-tube type convective heat exchanger, condensing potassium vapor inside the tubes and using NaK 78 as the shell side coolant. The other unit was a radiative type condenser, consisting of 9 coplanar, parallel-finned tubes manifolded to common inlet and outlet headers. This unit was tested inside an oil-cooled chamber in a vacuum environment of 3×10^{-3} torr. The objective of the tests was to study the performance and operating problems associated with current state-of-the-art units at near realistic operating conditions. The tests were conducted in the Space Radiator and Condenser Facility at the NASA Lewis Research Center. Results obtained from these tests as well as a description of the units tested are presented. A brief description of the facility and its capabilities is also included. It appears from these tests that it is possible to operate either type of multitube condenser in a stable manner over a large range of operating conditions. The advisability of using cocurrent coolant flow at the vapor inlet end of convective condensers is indicated, and the importance of properly evaluating inlet pressure drops is also pointed out by the results. (auth)

33489 (CONF-651026, pp 716-36) DESIGN AND DEVELOPMENT TESTS OF DIRECT-CONDENSING POTASSIUM RADIATORS. Fraas, A. P. (Oak Ridge National Lab., Tenn.).

Six tapered tube direct condensing radiators were built and operated in the course of the boiling potassium reactor system development test program at ORNL, and a number of tests were run with individual tubes. The bases for the design of these units and the more significant results of the test program are summarized, and some implications relative to future design work are discussed. (auth)

33490 (CONF-651026, pp 737-68) RESULTS OF HYPERVELOCITY IMPACTS INTO SPACE RADIATOR MATERIALS. Clough, Nestor; Diedrich, James H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

The results of an experimental hypervelocity impact program designed to evaluate various materials as armor for waste-heat radiator applications are discussed. Total damage, such as dimple, spall, and perforation, as well as simple cratering, was investigated in both flat plate and tubular targets. Projectiles of approximately 0.016 and 0.040 gram were accelerated to velocities of nominally 25,000 feet per second and impacted against various materials and configurations at room and elevated temperatures. The materials investigated include various aluminum alloys, stainless steel, columbium 1-percent zirconium, molybdenum, vanadium, tantalum, Inconel, A-286, L-605, graphite, and various types of beryllium. Significant differences in the ability of the various materials to resist dimple, spall, and perforation were observed in both flat plate and tubular configurations. The unique behavior of materials subjected to high-velocity impacts is clearly demonstrated. (auth)

33491 (N–65-32113) THEORETICAL STUDY OF NON-EQUILIBRIUM IONIZATION IN THE PRESENCE OF ELECTRIC AND MAGNETIC FIELDS. Progress Report No. 3, February 1–July 31, 1964. Hassan, H. A. (North Carolina State Univ., Raleigh. Dept. of Mechanical Engineering). 4p. (NASA-CR–58723). CFSTI $1.00 cy, $0.50 mn.

A one-dimensional analysis was used to predict the thrust from a coaxial plasma accelerator. The results of the analysis proved to be rather unsatisfactory because of the bulging of currents. As a result of bulging, E_x, the component of $\bar{E}$ in the direction of acceleration, changes sign, and no suitable average of E_x could be obtained which would bring out the important features of the acceleration mechanism. The one-dimensional analysis showed, that in regions not dominated by viscous stresses, the Hall effect was more important than conversion of rotation into directed motion as an acceleration mechanism. The thrust is due mainly to conversion of thermal energy into directed energy and to the Hall effect. (STAR)

33492 (N–66-12158) COMBINED HIGH-LOW THRUST PROPULSION FOR THE CLOSE SOLAR PROBE MISSION. Strack, William C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec. 1965. 35p. (NASA-TN–D-3145). CFSTI $2.00 cy, $0.50 mn.

Several types of propulsion systems are evaluated for the 0.1-AU solar probe mission commencing from a low, circular Earth orbit. The four propulsion systems compared are the chemical rocket, the nuclear rocket, the electric rocket, the chemical-electric hybrid system. The chemical-electric hybrid system consists of a chemical first stage fired until at least escape velocity is attained and an electrically propelled second stage. For this comparison, calculus of variations calculations were performed upon a mathematical model set up for electric and chemical-electric hybrid systems employing constant-thrust engines. It is shown that the chemical-electric hybrid is by far the most attractive system for present and near future power-plant technology. In particular, the Saturn 1B booster cannot deliver any payload to 0.1 AU if existing (or near future) hardware is utilized regardless of the upper stage propulsion choice except for the chemical-electric hybrid system. The study considers mission times between 60 and 650 days and specific electric power-plant masses from 10 to 150 pounds per kilowatt. (auth)

33493 (N–66-13000) SOLAR-POWERED ELECTRIC PROPULSION SPACECRAFT. Bi-Monthly Report No. 3, July–August 1965. Stivers, Robert H. (Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.). Sept. 1965. Contracts NAS7-100; JPL-951144. 149p. (NASA-CR-68374). CFSTI $4.00 cy, $1.00 mn.

For Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

Physical work on the development of a solar powered electric propulsion spacecraft during July and August 1965 centered on studies of the propulsion system and hardware, spacecrafts system design, and extension of the low thrust mission analysis to include fly-by heliocentric transfer trajectory from 1971 to 1975. The effect of power level on the design and operating characteristics of the Hg pool cathode electron-bombardment ion engine and its feed system was investigated; a conceptual design of a modularized pool cathode engine system was devised; a preliminary analysis of the thermal, mechanical, and electrical integration problems associated with the ion engine was performed; and the thrust vector displacement in redundant thrustor arrays was investigated. Present system design efforts involved the extension of the spacecraft bus to a 100 inch square cross section in lieu of the 100 inch cylindrical envelope. A proposed general arrangement for the Saturn IB/Centaur Solar Electric Propulsion spacecraft is presented. (STAR)

33494 (N–66-16920) ANALYSIS OF ELECTRON-ION MIXING IN ION ENGINES. Final Report, April 30, 1964–June 30, 1965. Wadhwa, R. P.; Brauch, D. F. (Litton Industries, San Carlos, Calif. Electron Tube Div. Research Lab.). July 20, 1965. Contract NAS3-5757. 150p. (NASA-CR–54419). CFSTI $4.00 cy, $1.00 mn.

The two-dimensional computer program for analyzing electron-ion mixing in ion engines was extended to new geometrical configurations. The program consists of injection of ions and electrons from appropriate locations as in an ion engine. The initial velocity distribution of the ions injected across the injection plane and the voltage variation along this plane are appropriately simulated. The injection plane is arbitrarily fixed according to convenience; on the left side of this plane lie the ion source and the other focusing electrodes while on the right side of this plane lies the electron emitter, which emits electrons according the Maxwellian distribution. Two sets of ion-beam configurations are analyzed; one corresponds to high voltage and the other to low voltage. Several values of ion-to-electron-mass ratio are considered and a comparison is made between the withdrawn

and immersed electron emitters. Different values of primary electron emission are simulated. (auth)

33495 (NAA-SR-Memo-11747) MERCURY RANKINE PROGRAM SYSTEM TEST EXPERIENCE. Poucher, F. W.; Gresho, P. M.; Wimberly, F. C. (Atomics International, Canoga Park, Calif.). Jan. 25, 1966. Contract AT-11-1-GEN-8. 74p. (CONF-651026-8). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

From 1st AIAA Rankine Circle Space Power System Specialists Conference, Cleveland.

Considerable test experience (over 2300 hours) was accumulated at Atomics International in the area of complete Mercury Rankine systems. This testing included a space-configured system operating in a vacuum chamber, a structural mockup system for vibration testing, and a system designed to simulate the effects of zero gravity condensing. Each of these system tests has contributed significantly toward a better understanding of the operation of a Mercury Rankine system and the combination of systems has demonstrated the feasibility of ground startup, launch survival, simulated orbital startup, and simulated steady-state operation in space. The basic objectives and overall accomplishments of these systems are discussed, the experience gained in test operations is presented, and the significant test results are summarized and discussed. (auth)

33496 PERFORMANCE OF AN ELECTRICALLY TRIGGERED REPETITIVELY PULSED COAXIAL PLASMA ENGINE. Gorowitz, Bernard; Karras, Thomas W.; Gloersen, Per (General Electric Co., Philadelphia). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1027-31(June 1966).

As a result of a succession of changes in propellant loading, electrode geometry, and mode of discharge initiation, the over-all efficiency of a repetitively pulsed, coaxial plasma engine was determined to vary from 35 to 70% in the specific impulse range of 3000–9000 sec. The values reported are based on direct measurements of engine thrust and total mass flow. Eroded mass was credited toward increasing the effective propellant load. Operation of the engine in the electrically triggered mode with axial propellant injection has permitted greater control over the prefiring propellant distribution and time of discharge initiation than could be achieved previously. The result has been a substantial increase in propellant mass utilization accompanied by a lowering of the specific impulse range to values deemed more suitable for presently contemplated missions. The results obtained from the preceding thrust balance and mass flow measurements were compared with the results from calorimetry of the engine exhaust stream. (auth)

33497 ELECTRON-MAGNETIC-FIELD INTERACTIONS IN THE ELECTRON-BOMBARDMENT-HEATED THRUSTER. Starner, K. E.; Grabowsky, W. R. (Aerospace Corp., El Segundo, Calif.). Contract AF 04(695)-459. AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1090-2 (June 1966).

Measurements obtained while investigating detailed electron-magnetic field interactions and power limitations in the coaxial filament and anode geometry of electrothermal thrustors are presented. (B.G.D.)

33498 PERFORMANCE PARAMETERS FOR ELECTRIC-PROPULSION SYSTEMS. Mickelsen, William R. (Colorado State Univ., Fort Collins). J. Spacecraft Rockets, 3: 213-18(Feb. 1966).

Electric spacecraft performance depends critically on the mass of the electric-propulsion system. The electric powerplant often is assumed to be the major component of such systems. It is shown, however, that when power conversion, power conditioning, and thrusters are included in mission analysis, the total effective specific mass α_{pe}^{*} (kg/kwj) of the electric-propulsion system may be much higher than that of the electric powerplant alone, resulting in significant loss of payload or increase in trip time. A method of system analysis is presented which clearly evaluates the contribution of each subsystem to the total propulsion system mass. (auth)

33499 IMPACT OF PROPELLANT HEATING ON NUCLEAR SPACECRAFT INSULATION AND PRESSURIZATION SYSTEMS DESIGN. Brogan, J. J. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). J. Spacecraft Rockets, 3: 932-4(June 1966).

Liquid hydrogen propellant on a nuclear stage is exposed to space and nuclear heating. The combined and separate effects of these heating sources on propellant tank insulation and pressurization system design requirements are described. (B.G.D.)

Vacuum Engineering

33500 CRYOSORPTION-PUMPED ULTRAHIGH VACUUM CHAMBER. Caldwell, R. R.; Gareis, P. J.; Simson, J. P. (Union Carbide Corp., Tonawanda, N. Y.). 30p. (CONF-651046-3). ORAU. Gmelin, AED-CONF-65-403-2.

From 12th National Symposium of the American Vacuum Society, New York.

A complete environmental chamber system has been built in which cryosorption is used as the sole means of obtaining ultrahigh vacuum. The complete system, supplied to the Air Force, demonstrated the ability to achieve an ultraclean vacuum in the 22 cu. ft. bakeable chamber better than the 5×10^{-11} Torr required. Linde Molecular Sieve bonded to a liquid helium cooled surface is used for adsorbing non-condensible gases. Other surfaces cooled by the vaporized helium and by liquid nitrogen cryopump the higher boiling gases. Location of the cryosorption pumping system inside the chamber permits utilization of the net pumping speed without conductance limitations imposed by piping or baffles. Steady-state pumping speeds of 13,000 l/sec for hydrogen and 7,900 l/sec for helium have been demonstrated. (auth)

GEOLOGY, METEOROLOGY, AND MINERALOGY

General

33501 ADSORPTION OF CERIUM ION BY VARIOUS SOLID SUBSTANCES IN AQUEOUS SOLUTION. Tarutani, Toshikazu; Misumi, Seizo (Kyushu Univ., Fukuoka). Mem. Fac. Sci. Kyushu Univ., Ser. C, 5: 21-6(Aug. 1962).

Experiments were conducted with ^{144}Ce to evaluate the extent of adsorption of this element on suspended matter in river water. It was necessary to assume the amount of suspended matter. The amount of suspended matter in water tested, near the mouth of Chikugogawa River, Kyushu, was a few hundred milligrams per liter. This river was adopted as a model for experiment with solids of less than 1 g/l. A 10-mg deposit of Chikugogawa water adsorbed about 90% of cerium in solutions of pH 6 and 8 and of sea water. With bentonite, the percentage of cerium absorbed in a solution of pH 8 was larger than that in sea water, but the difference between them was small. Bentonite and quartz showed maximum adsorptions at about pH 8. The percentage of cerium adsorbed by kaolinite and calcite increased with increasing pH. It was found that the adsorption of cerium by solid substances agreed well with the Freundlich adsorption isotherm. As the deposit of Chikugogawa is a good adsorbent of cerium, it is evident that a considerable amount of cerium is adsorbed by muddy suspensions in river water. It is presumed that cerium is accumulated in mud of marine sediment. (BBB)

33502 THE INTERNATIONAL MARINE RADIOACTIVITY LABORATORY AT MONACO. pp 101-16 of STI/DOC-10/55.

Diffusion processes in the sea, hydrography and plankton, chemistry of sea water and marine organisms, chemistry of sediments, and radiobiology of marine organisms were studied. (M.C.G.)

Meteorology

See also Site Survey and Selection

33503 (AECL-2575) FREQUENCY OF OCCURRENCES OF MAXIMUM POLLUTION LEVELS FROM SINGLE STACKS. Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). June 1966. 8p. (CONF-660622-1). Dep. mn. AECL $0.50.

From Royal Meteorological Society, National Meteorology Congress, Sherbrooke, Quebec, Can.

A radioactive noble gas, argon-41, is discharged continuously from the CRNL stack at an almost constant rate. The concentration of the gas at ground level was measured continuously at four sampling stations at various distances around the stack. The magnitude of extreme pollution levels occurring in the vicinity and also the frequency with which extreme levels of different magnitudes occur were estimated from the results. The occurrence of extreme pollution levels is related to such meteorological variables as atmospheric stability and wind turbulence. (auth)

33504 CHARACTERISTICS OF GLOBAL TROPOSPHERIC MIXING BASED ON MAN-MADE ^{14}C, ^{3}H, AND ^{90}Sr. Lal, D.; Rama (Tata Inst. of Fundamental Research, Bombay). J. Geophys. Res., 71: 2865-74(June 15, 1966).

Study of global dispersion of radiocarbon, radiohydrogen, and radiostrontium injected in the atmosphere by recent Soviet nuclear tests support the existence of the 0–30° Hadley meridional circulation cell. The rate of meridional mixing within the troposphere is evaluated; the analysis reveals a strong seasonal dependence for the exchange of air across 30°N latitude in the troposphere. The annual mass transport of air across the equator is evaluated. (auth)

33505 SOME ASPECTS OF THE GENERAL CIRCULATION OF THE LOWER STRATOSPHERE. Newell, Reginald E.; Miller, Alvin J. (Massachusetts Inst. of Tech., Cambridge). pp 392-404 of Proceedings of the Second AEC Conference on Radioactive Fallout from Nuclear Weapons Tests, Germantown, Md., Nov. 3-6, 1964. (MIT-2241-19).

A review is presented of the temperature and wind structure of the lowest 80 km of the atmosphere. The interaction between radiative and dynamic processes to produce the observed temperature distribution is discussed. It is concluded that the lower stratosphere and the mesosphere receive energy from the regions immediately below. It appears that mass transfer in the lower stratosphere is primarily accomplished by large-scale eddy processes. Forced mean meridional circulations arise from these processes; the possible magnitudes and signs of the mean circulations are examined. Various terms in the energy budget of the lower stratosphere are presented and discussed for the period of the International Geophysical Year. (auth)

Natural Radioactivity and Fallout

See also HEALTH AND SAFETY

33506 (AD-634534) EXPANSION OF FALLOUT-RADIATION NUMBER-SPECTRA CALCULATIONS TO LOW ALTITUDE. McDermed, O. L.; DeVries, T. W. (General Dynamics/Fort Worth, Tex.). July 1, 1966. Contract N228-(62479)69007. 129p. (FZK-291). CFSTI $4.00 cy, $1.00 mn.

Gamma-ray number and dose-rate spectra in the air above a smooth, quasi-infinite ground uniformly covered with fallout fission products are calculated. The spectra are calculated for 11 decay times, from 1.12 hours to 97.3 days, and at 7 altitudes, from 3 to 200 ft. The spectra are analyzed for the effects of altitude and decay time on spectral shape, with trends illustrated by computer tabulations and selected graphs. Results show that the spectra soften with increasing altitude and that they soften with decay time for about 2 days, become slightly harder for about 3 weeks, then resume softening. Reduction of total dose rate with altitude is nearly independent of decay time (below 400 feet). A related study, to determine the effects of ground roughness, is recommended. (auth)

33507 (AD-634901) THE CONTAMINATION BEHAVIOR OF FALLOUT-LIKE PARTICLES EJECTED BY VOLCANO IRAZU. Miller, Carl F. (Stanford Research Inst., Menlo Park, Calif.). Apr. 1966. Contract N228-(62479)69928. 67p. CFSTI $3.00 cy, $0.75 mn.

Photographs of objects contaminated with particles ejected from volcano Irazú in Costa Rica are presented to indicate the nature of particle behavior in various environmental situations. The similarity between the particles ejected by the volcano and the fallout particles produced by land-surface nuclear detonations suggests that the contamination behavior of the radioactive fallout particles would be similar to that observed for the volcanic particles. The peculiarities of the particle behavior are discussed in general terms in the figure captions for each situation depicted. (auth)

33508 (COO-1199-8) STUDY OF RAINOUT AT RADIOACTIVITY IN ILLINOIS. Fourth Progress Report. Huff, Floyd A.; Bradley, Wayne E. (Illinois State Water Survey, Urbana). Oct. 1965. Contract AT(11-1)-1199. 27p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Studies of fallout in rain in Illinois in 1962 to 1964 are reviewed. The 1965 program is described. Surface air and precipitation samples were collected during 14 rains and analyzed for gross beta activity. (M.C.G.)

33509 (EUR–2961.f) LES RESSOURCES EN URANIUM DANS LA COMMUNAUTE EUROPEENNE. (Uranium Resources in the European Community). (European Atomic Energy Community). May 1966. 40p. Dep. mn.

Researches conducted up to 1964 in Community countries revealed resources amounting to about 31,000 tons of U metal exploitable at a price of $8 per lb U_3O_8. Experts believe that uranium resources developable at a comparable price may be increased by means of a prospecting program in three of the Community countries (Germany, France, and Italy). It is difficult to assess the exact tonnage of the probable additional resources; however, they are estimated as about 10,000 tons of U in Germany, 20,000 tons in France, and 10,000 tons in Italy. (auth)

33510 (SFL–A4) ^{90}Sr AND ^{137}Cs IN WATER IN FINLAND. Salo, Anneli (Institute of Radiation Physics, Helsinki (Finland)). Apr. 1966. 14p. Dep. mn.

Results are tabulated for the ^{90}Sr and ^{137}Cs analyses of precipitation collected at 17 stations in Finland in 1961–1965. Concentrations of ^{90}Sr and ^{137}Cs are given for surface-water samples taken from lake and river systems in 1963–1965. The mean values for ^{90}Sr and ^{137}Cs were 2 pCi/l and 1 pCi/l respectively in 1964. (auth)

33511 (UCRL–14668) SIMULATION OF PARTICULATE FALLOUT. Rynders, Gerald F. (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 31, 1966. Contract W-7405-eng-48. 20p. (CONF-660424–1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Conference on the Fallout at the Naval Radiological Lab., Monterey, Calif.

A radio-frequency induction plasma generator is being used to obtain chemical reactions similar to those encountered in nuclear explosions. Thermal plasmas are produced by this technique at 4,000 to 20,000°K, and offer high enthalpic input and freedom from container contamination. While material fed into the plasma may not reach these temperatures, the more refractory oxides can be vaporized completely. Reactions of interest generally occur below 3000°K. In this system, completely enclosed for better control of the environment, gas-gas and/or gas-liquid reactions are studied by variation of parameters such as average particle size, feed rate, residence time, and power input. A monodisperse system of feed particles results in bimodal distributions of particles. The larger particles result from melting of the original particles (a consequence of short residence time); their shape is controlled by surface tension. They may be solid or hollow, crystalline or glassy. Some of the hollow spheres have internal negative crystals. Particles condensed from vapor are sub-micron in size because of the short quench time which limits growth. Both types of particles are similar to those found in nuclear explosion debris. A discussion of the relationship of the experimental parameters to those expected in formation of fallout is included. (auth)

33512 STUDY OF THE FORMS OF SOME FISSION PRODUCTS ARRIVING AT THE EARTH'S SURFACE. Pavlotskaya, F. I.; Zatsepina, L. N. At. Energ. (USSR), 20: 333-7(Apr. 1966). (In Russian).

The migration and the type of fallout were studied for several samples from the Moscow region. It was found that the distributions of certain radioactive isotopes among the soluble and insoluble radioactive fallout fractions are determined by the chemical properties, the amount of solid phase, the type of fallout, and their physical condition. (G.O.Y.)

33513 RELATION BETWEEN RADIOACTIVE FALLOUT AND PRECIPITATION. Yokoyama, Yuji (Centre d'Etudes Nucleaires, Saclay, France. CNRS, Gif-sur-Yvette, France). Compt. Rend., Ser. B, 262: 1409-12 (May 23, 1966). (In French).

Numerous works have been devoted to the study of the ratios between radioactive fallout and the volume of precipitations, but none has been sufficiently precise to permit a deduction of the fallout mechanism. It is shown here that there exists a unique relation governing the relation between radioactive fallout and precipitation, independent of time and geographic position. This relation was expressed by a formula and numerous important data were deduced by it. (tr-auth)

33514 RADIOACTIVITY OF SANDS IN CENTRAL ASIA. Boltneva, L. I.; Buyanova, L. I.; Dmitriev, A. V.; Ionov, V. A.; Kogan, R. M.; Nazarov, I. M. Dokl. Akad. Nauk SSSR, 165: 183-6 (Nov. 1, 1965). (In Russian)

Sandy areas in Central Asia were aerially surveyed by a gamma scanning method. The sands were classified into sands of different origins but having undergone aeolian transformation and sands of alluvial origin. In sands of the first group the uranium, thorium, and potassium distributions were relatively constant throughout the extent of the massifs, with a thorium/uranium ratio of 1.4 to 3.6. The average concentrations of the radioelements correlated with the radioactivity of the rocks from which the sand particles originated. In the sands of the second group the uranium and thorium concentrations decreased somewhat the farther the material was transported from its origin. However, the thorium/uranium concentration ratio changed little. The potassium concentration was rather constant. Despite local variations, however, the uranium and thorium concentrations were surprisingly constant, and it was concluded that chemical processes, e.g., leaching, do not play any significant role in the transportation of such material. (TTT)

33515 ISOTOPIC COMPOSITION OF URANIUM IN THE WATERS AND SEDIMENTS OF THE BLACK AND AZOV SEAS. Nikolaev, D. S.; Lazarev, K. F.; Korn, O. P.; Yakunin, M. I.; Drozhzhin, V. M.; Samartseva, A. G. Dokl. Akad. Nauk SSSR, 165: 187-9(Nov. 1, 1965). (In Russian).

Alpha-spectrometric examinations of uranium separated from the waters and the bottom sediments of the Black and Azov Seas indicated an enrichment of ^{234}U in the samples. The $^{234}U/^{238}U$ values found were 1.10 to 1.28 for the waters and 0.89 to 1.20 for the sediments, in general somewhat higher than the value of 1.15 quoted for the ocean. This may reflect a different age and geochemical history of the waters. The preferential leaching of the daughter ^{234}U from the rock-forming minerals in comparison with the mother element, ^{238}U, may occur. The degree of enrichment depends on various factors, including the chemical composition of the liquid and solid phases, disintegration of the latter, and time of contact. For the studies the uranium was separated from the waters by precipitation with iron hydroxide from samples of up to 580 liters and from the sediments by acid or bicarbonate leaching. (TTT)

33516 URANIUM, THORIUM, AND POTASSIUM IN SIX U.S.G.S. STANDARD ROCKS. Morgan, J. W.; Heier, K. S. (Australian National Univ., Canberra). Earth Planet. Sci. Lett., 1: 158-60(July 1966).

Six standard rocks, andesite AGV-1, basalt BCR-1, dunite DTS-1, granite G2, granodiorite GSP-1, and peridotite PCC-1, distributed by the United States Geological Survey, were analyzed for uranium, thorium, and potassium using the techniques of gamma-ray spectrometry, flame photometry, and neutron activation analysis. Results are shown, and standard-deviation errors for the gamma spectrometric measurements are given. (M.J.T.)

33517 OXYGEN ISOTOPE STUDY OF SNOW AND FIRN ON AN ALPINE GLACIER. Deutsch, S. (Univ. Libre, Brussels). Earth Planet. Sci. Lett., 1: 197-201 (July 1966).

Mean seasonal variations of the $^{18}O/^{16}O$ ratio between winter and summer precipitations are shown to be of the order of 14‰, on the Kesselwandferner (Ötztal, Austria, 3240 meters). The mean ^{18}O content of a 4.7 m deep firn section, representing three years accumulation, is similar to that of the precipitations, whereas its δ_{ox} profile displays highly damped oscillations, of the order of 3‰. The measurement of accumulation of snow, based on seasonal variations of δ_{ox} in firn, appears to be unreliable in this case, as shown by the comparison of the δ_{ox} and stratigraphic profiles. (auth)

33518 THE SUMMER 1957-1958 AT THE SOUTH POLE. AN EXAMPLE OF AN UNUSUAL METEOROLOGICAL EVENT RECORDED BY THE OXYGEN ISOTOPE RATIOS IN THE FIRN. Picciotto, E. (Univ. Libre, Brussels); Deutsch, S.; Aldaz, L. Earth Planet. Sci. Lett., 1: 202-4(July 1966).

Climatological records from the Amundsen-Scott Station, South Pole, show the summer 1957-1958 to be characterized by periods of exceptionally warm air temperature and above-normal snow accumulation. The firn layer deposited during this summer displays an exceptionally high oxygen-18 content, as revealed by $^{18}O/^{16}O$ ratio profiles obtained from sampling in five pits dug alongside accumulation stakes and from previous measurements. (auth)

33519 MEASUREMENT OF RADIOACTIVITY IN SOIL. Vassilaki, Maria; Salmon, L.; Gibson, J. A. B. (Atomic Energy Research Establishment, Harwell, Eng.). Geochim. Cosmochim. Acta, 30: 601-6(June 1966). (AERE-R-4996).

A series of soils originating from different rock types was examined for their radioactive contents. The activities due to ^{226}Ra plus daughters, ^{232}Th plus daughters, and ^{40}K were determined in 3-kg samples on a stabilized scintillation γ spectrometer. The resulting pulse-height spectra were analyzed by a least squares method using existing computer programs. Variations of activity in local rock types were determined and radiation background was computed to form basic data for determining fallout from nuclear weapon tests in soil. Examples are given for ^{137}Cs and ^{54}Mn to indicate the sensitivity of the method. The range of activities observed in surface soil varied from 0.47 to 2.05 pc/g for ^{226}Ra plus daughters, 0.11 to 1.50 pc/g for ^{232}Th plus daughters, and 0.46 to 9.7 pc/g for ^{40}K. The activities of fallout isotopes were of the order of 0.5 pc/g for ^{137}Cs and 0.2 pc/g for ^{54}Mn. The distribution of activity with depth is given for some soils. (auth)

33520 THE GLOBAL FALLOUT OF ^{32}Si PRODUCED BY COSMIC RAYS. Kharkar, D. P.; Nijampurkar, V. N.; Lal, D. (Tata Inst. of Fundamental Research, Bombay). Geochim. Cosmochim. Acta, 30: 621-31(June 1966).

Geochemistry of silicon-containing molecules participating in the dynamic physical and chemical processes operative in the upper layers of the earth, the atmosphere, hydrosphere, and lithosphere was studied using the radionuclide ^{32}Si as a tracer. Results of measurements of its concentration in wet precipitations at several stations in India covering the latitude belt 10 to 30°N are described. Measurements are discussed in relation to the observations of fallout of the short-lived cosmic-ray-produced isotope, ^{7}Be. The observed fallout pattern of ^{32}Si is discussed in relation to the large-scale atmospheric processes operative in its eventual removal from the atmosphere. The analyses led to reasonable estimates of the rate of production of ^{32}Si in the atmosphere. This information is of significance for the interpretation of observed activities of ^{32}Si in the hydrosphere. (auth)

33521 GEOCHEMISTRY AND THE GENESIS OF THE HEEMSKIRK GRANITE, WEST TASMANIA. Heier, K. S.; Brooks, C. (Australian National Univ., Canberra). Geochim. Cosmochim. Acta, 30: 633-43(June 1966).

Heemskirk granite consists of two major granites: a red and a white variety; the latter is subdivided into series A and B. The white granites are characterized by exceptionally high initial $^{87}Si/^{88}Sr$ ratios (0.734 and 0.741). They have also abnormally low Th/U ratios when compared with the red variety as well as with granitic rocks in general. Their low K/Rb ratios reflect their strongly differentiated nature, and the abundance of cassiterite and sulfide mineralization within the white granites emphasizes the importance of a vapor phase. An abundance of tourmaline in all granitic varieties is further evidence of the presence of volatiles. Xenoliths are abundant in the white but nonexistent in the red granite. An interpretation of the granite genesis that is consistent with all the data assumes that the white granites are largely the product of the vapor phase acting on the top portion of the granite intrusion. Incorporation of the quartz feldspathic sediments of the roof occurred in this zone. The parent magma subsequently intruded and crystallized to form the red granite. (auth)

33522 ISOTOPIC COMPOSITION OF ARGON IN NATURAL GASES. Cherdyntsev, V. V.; Kolesnikov, E. M.; Lizarskaya, I. V. (Geological Inst., Academy of Sciences, USSR. Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 5, 604-6(May 1966). (In Russian).

The ratio of (He + Ne)/Ar, the % argon content from air, and the ratio of ^{40}Ar (radiogenic)/He are given for a number of natural gases taken from various deposits in Russia. The argon and helium contents were determined volumetrically, and the argon isotopic composition was obtained mass-spectrometrically. The error in determining the ratio (He + Ne)/Ar was about 1 to 5%. A significant number of the 54 natural gas samples show the presence of radiogenic argon. The highest ratio of ^{40}Ar (radiogenic)/Ar = 0.45 is obtained for a gas from a Devonian deposit. For most gases the ratio ^{40}Ar (radiogenic)/He is rather low, and lies within the limits of 0.03 to 0.05. (TTT)

33523 CONCENTRATION OF URANIUM IN MARINE DEPOSITS. Legin, V. K.; Kuznetsov, Yu. V.; Lazarev, K. F. Geokhimiya, No. 5, 606-8(May 1966). (In Russian).

A 0.7N sodium bicarbonate solution with a pH close to that of seawater was used as a leaching agent to investigate the mobility of uranium in sea deposits from the Azov and Black Seas. The dried sample was sieved to 5 mesh, and contacted for 20 hours with intense agitation of the above solution. The solution was separated from the solid by centrifugation, and the uranium content of the solution was determined by a luminescent method. Only 4 to 6% of the uranium could be extracted from the Azov Sea deposits, while almost 100% of the uranium was extracted from the Black Sea deposits. This sharp difference in uranium mobility indicated that the uranium in the Black Sea deposits was originally dissolved in the seawater, while the uranium in the Azov Sea deposits was of terrestrial origin. (TTT)

33524 RATIO $^{234}U/^{238}U$ AND THE URANIUM CONCENTRATION IN SEAWATER IN THE WESTERN NORTH PACIFIC. Miyake, Yasuo (Meteorological Research Inst., Tokyo); Sugimura, Yukio; Uchida, Tetsuo. J. Geophys. Res., 71: 3083-7(June 15, 1966).

The concentration of uranium and the activity ratio of $^{234}U/^{238}U$ in seawater collected in the Kuroshio region and in the area of the mixing of Oyashio and Kuroshio waters in the western North Pacific were determined. Uranium was analyzed by the absorption spectrophotometric method with Arsenazo-III after separating it with a chelating resin. The activity ratio was determined by α-particle spectrometry after electroplating concentrated samples on a silver disk. The average content of uranium of 3.31×10^{-6} g/l and the average activity ratio $A_{U^{234}}/A_{U^{238}}$ of 1.09 ± 0.05 were obtained. (auth)

33525 WHOLE-ROCK AND MINERAL LEADS FROM THE LLANO UPLIFT, TEXAS. Ulrych, T. J.; Reynolds, P. H. (Univ. of British Columbia, Vancouver). J. Geophys. Res., 71: 3089-94(June 15, 1966).

The development of lead isotope ratios in whole-rock systems may be considered to have taken place in two environments: the common lead environment, before the formation of the whole-rock system, and the radiogenic lead environment, after its formation. Zartman's lead data from the Llano Uplift were used in independent studies of the two environments. The radiogenic contribution gives concordant ages which agree with Rb/Sr determinations. The common leads which are interpreted by well-established techniques also yield numerical results that agree with the Rb/Sr values. Both approaches exhibit a two-stage history analogous to Rb/Sr results. (auth)

33526 OCEANOGRAPHIC IMPLICATIONS OF RADIOACTIVE FALLOUT DISTRIBUTIONS IN THE ATLANTIC OCEAN: FROM 20 DEG N TO 25 DEG S, FROM 1957 TO 1961. Bowen, Vaughan T. (Woods Hole Oceanographic Inst., Mass.); Sugihara, Thomas T. J. Marine Res. (Sears Found. Marine Res.), 23: 123-46(May 15, 1965).

The patterns of ^{90}Sr distribution in the equatorial Atlantic are described for the years 1957, 1958, 1960, and 1961. Evidence is drawn from analysis of surface samples and of vertical profiles. The concentration distributions bear no resemblance to patterns of fallout delivery on land; it is concluded that hydrographic processes are responsible for sea water concentration patterns. The data provide evidence for 2 otherwise unobserved, high fallout incidents over the Atlantic Ocean. The rapid vertical penetration of ^{90}Sr in the ocean and the relatively rapid attainment of horizontal and vertical uniformity of concentration in the equatorial Atlantic are consistent with patterns of current flow derived from hydrographic considerations only if these are complicated by very active unorientated mixing processes within water masses. Integration of vertical profiles yields estimates of fallout delivery to the equatorial ocean surface that are much higher than estimates of delivery to land surfaces at comparable latitudes. Vertical profiles of ^{144}Ce and ^{147}Pm show secondary concentration maxima at various depths; some of these maxima are interpreted as being local concentrations of sinking particles whereas others appear to represent retention in the bodies of plankton swarms. In most cases these secondary maxima are enriched in ^{147}Pm vs ^{144}Ce. (Public Health Abstr.)

33527 OBSERVATIONS ON CESIUM ENRICHMENT AND THE POTASSIUM/RUBIDIUM/CESIUM RELATIONSHIP IN ECLOGITES FROM THE ROBERTS VICTOR MINE, SOUTH AFRICA. Gurney, J. J.; Berg, G. W.; Ahrens, L. H. (Univ. of Capetown). Nature, 210: 1025-7 (June 4, 1966).

Eclogites and kimberlites from various locations in South Africa were analyzed quantitatively for trace amounts of cesium, potassium, and rubidium by emission spectrography. A strong correlation was apparent between potassium and rubidium concentrations in the samples analyzed. However, no definite relationship between cesium and potassium or cesium and rubidium concentrations could be established. The consistently high cesium values could not be readily explained. (J.G.B.)

33528 DEBRIS PARTICLES FROM THE SECOND CHINESE NUCLEAR BOMB TEST. Sisefsky, Jan (Research Inst. of National Defence, Stockholm). Nature, 210: 1143-4 (June 11, 1966).

A study was made of the upper-air and ground-air samples of debris from the second Chinese nuclear bomb test. The activities of these samples were compared to the USSR and USA tests and the first Chinese test. (D.H.M.)

33529 STUDIES ON FALLOUT PARTICLES. [PART] VI. Mamuro, Tetsuo (Radiation Center of Osaka Prefecture); Fujita, Akira; Matsunami, Tadao; Shirai, Shogo; Murakami, Masahiro. Nippon Genshiryoku Gakkaishi, 8: 309-16 (June 1966). (In Japanese).

X-ray microanalysis was carried out on the highly radioactive fallout particles originating from the first Chinese nuclear test explosion. Confirmation was obtained on the presence of seven metallic elements, Fe, Ca, Si, Al, K, Mn, and Ti in the particles. It was found that the four elements Fe, Ca, Si, and Al were the main constituent metallic elements and that the particle color increased its darkness with Fe composition. X-ray scanning images suggested that in some cases these elements were not distributed evenly in the particles. The present x-ray microanalysis revealed characteristics somewhat different from the Soviet fallout particles collected in autumn 1962, which may be due to difference in conditions of explosion. (auth)

33530 FALLOUT FROM CHINESE NUCLEAR TEST OF MAY 14, 1965. Gold, S.; Hardin, J.; Tabor, E.; Branson, B.; Kahn, B. (Public Health Service, Washington, D. C. Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio). Radiol. Health Data Rep., 7: 209-14 (Apr. 1966).

Daily air sampling activities by the National Air Sampling Network in the latter part of May 1965 indicated the arrival of fallout attributed to the second atmospheric nuclear test by the mainland Chinese. Recently formed fallout was first detected in 24-hour samples of airborne particulates collected May 19 and 20, 1965, by the Helena, Montana, station. The highest gross beta activity found during the month was 7 pCi/m^3 at Denver, Colorado, on May 21 and 22. The major gamma-emitting radionuclides in the Denver samples were neptunium-239, molybdenum-99, and tellurium-132. Samples from other cities counted a week later than those from Denver contained predominantly barium-140, iodine-131, zirconium-niobium-95, cerium-141, and ruthenium-103. Barium-140 detection in Cincinnati on May 21 and 22, and in New York on May 22 and 23, was noted in relation to the predicted arrival of fallout in the troposphere on May 19. Analyses of rain samples for barium-140 indicated deposition of fresh fallout by almost all rains occurring between May 22 and July 8. (auth)

33531 LEAD ISOTOPE STUDY OF MINERAL DEPOSITS IN THE KOOTENAY ARC. Sinclair, Alastair James. Vancouver, B. C., Univ. of British Columbia, 1964. 281p.

Thesis.

Twenty-one galena specimens from 16 mineral deposits in the Kootenay district analyzed isotopically in replicate have a linear relationship of isotopic compositions on a $^{206}Pb/^{204}Pb$ versus $^{207}Pb/^{204}Pb$ graph. Twelve of the galenas, including two from Sullivan mine (East Kootenay district), were analyzed by an intercomparison technique. Intercomparison results verify the linear compositional pattern (slope = 0.1084 ± 0.0033). These results indicate that Kootenay arc leads are multi-stage leads, that Sullivan-type lead is the parent common lead from which the anomalous suite developed, and that Kootenay arc mineral deposits formed during one major mineralizing episode. Lead isotopic compositions show no obvious correlations with age of wall rock, type of wall rock, geological nature of ore deposits, or minor element content of galena. The history of evolution of Kootenay arc anamalous leads is interpreted as follows: (1) formation of source rocks containing uranium and thorium about 1700 m.y. ago, (2) introduction of Sullivan-type lead into source rocks about 1340 m.y. ago, (3) mixing of Sullivan-type lead with radiogenic lead formed by decay of uranium and thorium, and transportation and deposition of these lead mixtures to form anomalous lead deposits during Coast Range orogeny. A method of estimating volume of source rock of anomalous lead deposits is outlined. Calculations for Jersey, Reeves Macdonald, and Bluebell mines indicate that the radiogenic lead component of these deposits could have been derived from 1 to 10 cubic kilometers of source rock containing 3 ppM uranium (and approximately 12 ppM Th) if only one-third to one-half of the radiogenic lead in the source were extracted during a period of concentration and mineralization. Minor element contents of galenas from Salmo-type replacement deposits suggest but do not prove a fairly low temperature of mineral deposition. (TCO)

Techniques and Equipment

Refer also to abstracts 33213 and 33723.

33532 DATING GREENLAND FIRN-ICE CORES WITH ^{210}Pb. Crozaz, G. (Univ. Libre, Brussels); Langway, C. C. Jr. Earth Planet. Sci. Lett., 1: 194-6 (July 1966).

The ^{210}Pb dating method is applied to deep thermally recovered firn-ice cores from the North Greenland ice sheet. The ^{210}Pb activity is found to decay exponentially with depth (expressed in water equivalent). The corresponding rate of snow accumulation, averaged over the past 150 years, is (32 ± 3) g/cm^2-yr, in good agreement with present day surface snow accumulation obtained by different methods. (auth)

33533 ANALYSIS OF CANADIAN LONG SHOT DATA. Jensen, Oliver (Arctic Inst. of North America, Ladd, Alaska); Ellis, R. M.; Russell, R. D. Earth Planet. Sci. Lett., 1: 211-21 (July 1966).

A pilot analysis of the Project Long Shot nuclear explosion data received by the Canadian seismic stations indicates a compressional first arrival as expected from an impulsive explosion source except at one station. At all stations the P phase arrived earlier than predicted with the largest residuals at the most distant sites. A comparison earthquake in the Rat Islands area indicates a similar bias trend. The average unified magnitude and standard deviation for all Canadian stations is shown to be 6.01 ± 0.40 which agrees well with the worldwide average determination of 5.99 ± 0.52. Surface waves, recorded at 4 stations, gave magnitudes from 4.9 to 5.2. The P wave amplitudes appear to be anomalously low in central British Columbia and high in eastern Canada. Spectral investigations show both common and individual characteristics among the stations. (auth)

33534 K–Ar DATING USING NEUTRON ACTIVATION FOR Ar ANALYSIS: GRANITIC PLUTONS OF THE EASTERN GREAT BASIN, NEVADA AND UTAH. Armstrong, Richard Lee (Yale Univ., New Haven). Geochim. Cosmochim. Acta, 30: 565-600(June 1966).

A technique of Ar analysis by neutron activation utilizing the reactions $^{40}Ar(n,\gamma)^{41}Ar$ (half life 110 min) and $^{36}Ar(n,\gamma)^{37}Ar$ (half life 35 days) was perfected for use in potassium–argon dating. The gas was extracted from minerals by fusion, and a known fraction sealed in an ultra-pure silica vial. Unknowns and standards were irradiated together and immediately after irradiation each sample was repurified in the presence of carrier argon and pumped into calibrated counter tubes, which were filled to 76 cm pressure with counting gas. Measurement of the ^{41}Ar and ^{37}Ar activities, which were distinguished by their differing half lives, permitted analysis for both ^{40}Ar and ^{36}Ar. By comparison with air standards of known volume and fixed ^{40}Ar to ^{36}Ar ratio it was possible to obtain an analysis for argon and a correction for air contamination. The precision and accuracy of the analysis are ~5%; due to Ar losses during sample preparation the confidence limits of the dates reported are +15%, –5%; counting statistics and uncertainty in the blank correction limit the precision and accuracy for very young samples with K contents >5% to ~±2 m.yr. Thirty granitic plutons in eastern Nevada and western Utah were dated. Plutons in the Southern Snake Range, Dolly Varden Mountains, Whitehorse Range, Cortez Range, Austin mining district, and at Mount Hamilton and Whistler Mountain were of Jurassic and early Cretaceous age. The Ruby Hill stock, Eureka mining district was latest Cretaceous, the Bingham Canyon stock early Eocene in age. All other dated plutons east of the Antler orogenic belt were of Oligocene and Miocene age, synchronous with major volcanism in the region. The older plutons and orogenic structures which they cross cut indicated that the Nevadan orogeny affected all of Nevada and not just the western half where eugeosynclinal rocks occur. There was no obvious association of age with chemical composition, association of ore deposits, petrography, or depth of emplacement; there appeared to be a positive correlation between shallow depth of emplacement and association of major mineral deposits and occurrence of porphyritic texture. Most lead-alpha dates agreed with the K–Ar results but a few were unrealistically old and must be explained by inherited radiogenic lead or contamination with common lead. (approx. 120 references). (auth)

33535 ISOTOPIC AGE DETERMINATIONS ON SURINAM ROCKS. Priem, H. N. A.; Boelrijk, N. A. I. M.; Verschure, R. H.; Hebeda, E. H. (Laboratorium voor Isotopen-Geologie, Amsterdam). Geol. Mijnbouw, 45: 16-19(Jan. 1965).

Rubidium-87, $^{87}Sr/^{86}Sr$, ^{40}K, and ^{40}Ar determinations were made on four Surinam rock samples. The Rb-Sr ages were determined on whole-rock samples, on biotite concentrates, and on a concentrate of muscovite. All micas were also dated according to the K-Ar method. The techniques used for the determination of rubidium, strontium, potassium, and argon are described. For rubidium-strontium measurements, the strontium was purified by cation exchange chromatography, while both rubidium and strontium were determined by isotope dilution. Measured ages in the first specimen were about 1900 million years (Myr). Only the K-Ar age of the muscovite from this sample was about 100 Myr lower, which could be attributed to a loss of part of the radiogenic argon by diffusion from the mineral. Sample 2 had a very low enrichment in radiogenic strontium, due to its high strontium/rubidium ratio (about 3.2). Consequently, the whole-rock Rb-Sr age was highly sensitive to the adopted $^{87}Sr/^{86}Sr$ ratio of the initial, contaminant strontium. For the whole-rock sample of specimen 4, no Rb-Sr age determination was possible. The whole-rock Rb-Sr age of specimen 3 was also close to 1900 Myr. For the biotite of this specimen, however, the Rb-Sr age as well as the K-Ar age are much lower: around 1300 Myr. It was concluded that the granites and quartz diorites investigated were emplaced about 1900 Myr ago. (BBB)

33536 USE OF ^{146}Sm IN AGE DETERMINATIONS. Nurmia, M.; Karras, M. (Univ. of Helsinki). Geophysica, 7: 83-90(1959–63).

It was determined that the initial isotopic abundance of ^{146}Sm in natural Sm was between 1 and 10%. It is assumed that the half life of ^{146}Sm is 3×10^8 yr and that the elements originated 5×10^9 yr ago. These quantities fix the initial isotopic abundance of ^{146}Sm as 3%, while its present isotopic abundance would be 3×10^{-5}%. This means that the abundance of ^{146}Sm 3×10^9 years ago was about 0.01%, and that a Sm mineral of this age should contain a corresponding excess of the decay product ^{142}Nd. Since the abundance of ^{143}Nd should simultaneously exhibit an excess of about 1% due to the decay of ^{147}Sm, ^{146}Sm would be useful in case of extremely old samples only. Because the activity caused by ^{146}Sm would be equal to that caused by ^{147}Sm about 3.3×10^9 yr ago, it is predicted that ^{146}Sm is likely to become important in geological dating in exceptional cases only. However, it may yield important information about the age of the universe if its half life can be accurately determined. (TCO)

33537 RADIOISOTOPIC COMBINED MOISTURE-DENSITY METER. Nagy, A. Z.; Razga, T. (Central Research Inst. for Physics, Budapest). J. Sci. Instrum., 43: 383-7(June 1966).

A combined system, developed for the simultaneous determination of humidity and density, consisting of a double scintillator and pulse shape discriminator within a single probe is described. Tests on the meter were performed in measurements concerned with soil mechanics. (auth)

33538 REVIEW OF GEOPHYSICAL METHODS AND DEVICES USED IN GEOPHYSICAL EXPLORATIONS IN HUNGARY. Istvan, Czegledi; Laszlo, Marko; Karoly, Sebestyen. Magyar Geofiz., 6: No. 1, 1-28(1965). (In Hungarian).

A review is given of the methods and instruments used in Hungary for geophysical drill hole measurements. It was established that the methods used at present require supplementary measurements. From a measurement of the electrical parameters the wide introduction of focusing-system methods and induction method represent the most logical point of development. The development of radiological methods should be devoted to the measurement of energy and to the increase of the working temperatures. Not only the technical but also the methodical preliminaries must be considered. The devices for the determination of the state of the drill hole must be improved with respect to the working temperature and to an increase of the precision. (tr-auth)

33539 EFFECT OF IRON ON MEASURING WATER CONTENT WITH A NEUTRON METER. Burn, K. N. (National Research Council, Ottawa). Nature, 210: 763-4(May 14, 1966).

Two investigations to determine the effects of iron and potassium content on moisture studies of soils with neutron scintillation-type depth probes are described. (B.G.D.)

33540 STUDIES ON METHODS USING RADIOISOTOPES FOR MEASURING NUTRIENTS MOVEMENT IN

SOIL COLUMNS. Chang, C. H.; Lai, T. M. (Taiwan Sugar Experiment Station, Tainan, China). Rep. Taiwan Sugar Exp. Sta. (Taiwan), No. 35, 119-32(Mar. 1964). (In Chinese).

A simple, convenient method was developed for measuring nutrient movement in soil columns. The movement of ^{32}P and ^{86}Rb in soil columns was measured by radioautography and linear scanning with a G-M counter after the column was leached with radioisotope-labeled solutions. A thin polyvinyl chloride bag was used to hold the soil column in a leaching tube. After leaching with ^{32}P or ^{86}Rb solution, the soil-column was removed from the leaching tube simply by pulling out the plastic bag. Then the column was dried and embedded in paraffin. The radioactivity of the solidified columns could be determined either by radioautography using x-ray film or by linear scanning with a G-M counter. The distribution pattern of nutrient movement in soil columns was categorized in 3 types. In the first type, a large amount of nutrient extended down to the lower layer of the column. The second type represented gradual downward movement from top of the column, a smooth slope appearing in the distribution curve. In the third distribution pattern the nutrient was leached only slightly, and most of it accumulated in the surface layer of the soil column. (TCO)

33541 USE OF TRACERS IN COASTAL ENGINEERING. Bruun, Per (National Engineering Science Co., McLean, Va.). Shore Beach, 34: 13-17(Apr. 1965).

Methods are described and examples presented for the use of radioisotopes for: tracing of patterns and relative magnitude of sediment transport; evaluation of the relative magnitude of drift in two opposite directions; determination of the depth to which sediment transport takes place; evaluation of the effectiveness of a dredging operation and evaluation of the source of material to be dredged; and checking the effectiveness of sand fences and traps. Applications not directly related to sand transport include, e.g., determination of the best location of intakes and outlets for cooling water systems, and determination of the pattern of relative magnitude of pollution caused by an outfall. A cardinal requirement of such a radioactive tracer is that it have the same transport qualities as the sediment in question. It must not under any circumstances separate from the normal sediment transport. The radioactive tracer method is particularly applicable because of the accurate and comparatively simple measurement of radioactivity. Another advantage is the fact that after a lapse of time a former measurement will not interfere with a second measurement when a tracer with a suitable half life has been chosen. This, however, can be a disadvantage when a suitable time lapse is not permissible. (BBB)

33542 ARTICULATED GAMMA-GAMMA BOREHOLE LOGGING APPARATUS. Saurenman, Dean F. (to Schlumberger Well Surveying Corp.). U. S. Patent 3,254,221. May 31, 1966. Filed Jan. 4, 1965.

In a gamma-gamma well logging apparatus, a relatively short, heavy skid housing is suspended from a main housing and contains the source and detector. A wall-engaging member is linked to the skid housing for relative movement so that the wall-engaging member and skid housing can be urged into contact with the wall of the well bore. A linkage system is provided for the wall-engaging member and skid housing for developing the relative movement between the two without the development of undesirable forces. The linkage system is powered by hydraulic means which are responsive to a hydraulic system in the main housing. (B.L.M.)

Thorium and Uranium Minerals

33543 PRODUCTS OF OXIDATION OF PITCHBLENDE FROM KLETNO. Banas, M. (School of Mining and Metallurgy, Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Geol. Geogr., 14: 23-6(1966).

At Kletno, a locality near Snieznik Klodzki (Middle Sudetes), a polymetallic mineral group has been discovered. The mineralization occurs in a series of metamorphic rocks amid shattered secondary quartzites, in the vicinity of garnet-amphibole-pyroxene skarns containing magnetite with sulfides. This mineralization took place at the contact zone of the Snieznik granite gneisses with crystalline limestones. Pitchblende occurs in quartz and fluorite veins, forming nests and irregular ore accumulations in a pitchblende-sulfide and a uranium-fluorite formation. It appears in colloform shell texture as well as in impregnated, compact, veined, or brecciated structures. Four varieties of this mineral were distinguished: nasturan I, II, III, and IV. They differ as to certain optical features (color tint, reflectivity, internal reflections), and as to microhardness. Most probably, pitchblende varieties III and IV are of secondary (oxidation) origin. Products of modification of pitchblende are: a substance resembling gummite, fourmarierite, uranophane, torbernite, and sharpite. The first two develop in situ, after nasturan, and usually constitute its pseudomorphs. The remaining products, on the other hand, originate from oxidized displaced material. Only the first two minerals are considered. (BBB)

33544 DISTRIBUTION OF MOLYBDENUM, URANIUM, COPPER, AND OTHER ELEMENTS IN NORTHWESTERN SPURS OF NORTH TIEN SHAN. Rekharskii, V. I. (Inst. of the Geology of Ore Deposits, Petrography, Mineralogy, and Geochemistry, Moscow). Int. Geol. Rev., 8: 530-48 (May 1966).

The average content of molybdenum, uranium, and copper in rocks of southeastern spurs of North Tien Shan was determined as 1.1, 2.1, and 25.6 g/ton, respectively. The following relation was established between the standard content of these elements and the age and composition of the volcanic rocks: going from older to younger intrusive complexes, the content of molybdenum and uranium rises while that of copper falls; the acidic rocks are higher in molybdenum and uranium, and the basic rocks are high in copper. In the course of volcanism, the subalkaline rocks are enriched in all three elements; the same is true for marginal parts of the acidic intrusions where feldspar-quartz metasomatics are particularly common. The calculated concentration coefficients indicate a faster accumulation rate for uranium as compared with molybdenum, in the acidic rocks, in the course of volcanism. The marked periodicity of concentration coefficients for the elements suggests that these coefficients reflect a natural law of elemental distribution. (BBB)

33545 URANIUM METALLOGENIC EPOCHS. Morozenko, N. K. (Leningrad Mining Inst.). Int. Geol. Rev., 8: 608-20(May 1966).

The relative distribution of uranium reserves throughout the world in deposits of various origin and age, as a basis for outlining the metallogenic epochs is surveyed. No era is either uraniferous or barren of uranium on a worldwide scale. Beginning with the late Archean, commercial uranium deposits occur in all eras and their periods. Thus there is no reason for preferential exploration for uranium in rocks of any period. However, some eras and periods are more uraniferous than others, with respect to certain large provinces and even continents. Uranium reserves decrease in going from the older eras to the younger. All eras, except the Paleozoic, show a preponderance of endogenous deposits over the exogenous and metasedimentary. An era-by-era comparison is made of the present commercial uranium deposits and those with very lean ores. Occurrence of uranium is genetically related not to large batholiths particularly common in the Archean and Proterozoic, but rather to minor intrusions and subvolcanic formations. Acidic-to-intermediate subvolcanic and volcanic formations, often alkaline, are present in the Paleozoic; they are more common in the Mesozoic, and even more so in the Cenozoic. Many commercial deposits of the uraninite, uraninite-sulfide, and uraninite-fluorite types are associated with them. (TCO)

33546 SCHWARTZWALDER URANIUM MINE, JEFFERSON COUNTY, COLORADO. Downs, George R.; Bird, Allan G. Mountain Geol., 2: 183-9(Oct. 1965).

The lithology, structure, mechanism of pitchblende deposition, development, and reserves of the Schwartzwalder uranium mine are described. Ore shipments of 133,000 tons of 0.78% average grade ore have yielded more than 2,000,000 pounds of U_3O_8. Unmined reserves are believed to exceed the amount already produced. The ore body is classed as a typical hydrothermal vein-type ore deposit. Primary pitchblende is the principal ore mineral. The host rocks are units of the Idaho Springs Formation of Precambrian age. Deposition of the ore occurred during early Tertiary time. The fissure veins are parallel to and located about 400 yards southwest of the Rogers breccia reef, a northwest-trending Laramide fault of large displacement. The pitchblende occurs as microscopic colloform and fibrous coatings on breccia fragments, particularly rich in black pyrite, on crystals of adularia (a vein type of potash feldspar), and also on the complex carbonate, ankerite, $CaCO_3$, (Mg, Fe, Mn)CO_3. (TCO)

33547 NOTE ON THE RADIOACTIVITY OF JAMAICAN BAUXITE AND TERRA ROSSA. Vincenz, S. A. (St. Louis Univ.). Overseas Geol. Mineral Resour., 9: 295-301(1964).

Extensive γ-radiation ratemeter observations were made over mineral deposits in various localities and at various elevations. Observations were also conducted in limestone areas to obtain a value for the average radiation background in the island of Jamaica. The background varied from 0.004 to 0.007 mR/hr, while the readings over terra rossa and commercial grade bauxite varied from 0.01 to 0.04 mR/hr and in some areas reached even 0.07 mR/hr. Radiometric assays of samples of bauxite and terra rossa obtained from various localities were made. It was concluded that, in general, the equivalent U_3O_8 in the bauxite and terra rossa varied from 0.004% to 0.0075% and amounts to about 0.012% in red mud. The radiometric assays showed that the processing of bauxite caused a selective concentration of the radioactive minerals in red mud (ferruginous fraction). Therefore, the radioactive minerals are associated with the ferric oxide and ferric hydroxide which form the ferruginous impurity in bauxite. Radiochemical analyses of terra rosa showed 0.0015% U_3O_8 and 0.0025% ThO_2. (TCO)

HEALTH AND SAFETY

See also BIOLOGY AND MEDICINE — Radiation Hazards and Protection
GEOLOGY, METEOROLOGY, AND MINERALOGY — Natural Radioactivity and Fallout

Refer also to abstracts 33215, 33436, and 33744.

33548 (CONF-650577–1) ADHESION OF PARTICLES TO SURFACES IN LIQUID AND GASEOUS ENVIRONMENTS. Walker, Robert L.; Fish, Birney R. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 6p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A summary of the dependence upon particle radius of the various adhesive and removal forces is presented. On the basis of theory, if the particle size is reduced by a factor of 2 the capillary and Van der Waals forces also will decrease by a factor of 2, while the electrostatic forces will decrease by a factor of 4. Removal forces generally decrease more rapidly with particle size than do adhesive forces, consequently the smaller the particles the more difficult they are to remove. Mechanical contact techniques decrease in efficiency less rapidly with particle size than do the other removal procedures, hence is the method of choice where conditions permit. Research now underway is directed toward gaining an understanding of the adhesive and the removal forces involved in the cleaning of contaminated surfaces and in the prevention of recontamination. (J.R.D.)

33549 (CONF-660308, pp 131-42) AEC MATERIALS MANAGEMENT POLICIES. George, Douglas E. (Division of Nuclear Materials Management (AEC), Washington, D. C.).

Broad aspects of the AEC's nuclear materials control system are discussed. The specific topics discussed pertains to transfers, records and reports, and procedure manuals. (M.O.W.)

33550 (CONF-660308, pp 143-8) AEC REGULATORY PRACTICES AND POLICIES FOR LICENSING PLUTONIUM PLANTS. McBride, J. A. (Division of Materials and Licensing (AEC), Washington, D. C.).

Comments were made on the general criteria used by the AEC Regulatory Staff in the evaluation of license applications covering processing and transportation of plutonium. Because of the unusually high radiotoxicity of plutonium and the pyrophoricity of plutonium metal, particular emphasis must be placed on the applicant's proposed controls over the confinement and containment of the plutonium, and his methods of fire prevention and emergency controls in the event of fire, explosion, or other accidents likely to affect containment adversely. (M.O.W.)

33551 (CONF-660308, pp 149-58) PLUTONIUM HANDLING AND CONTROL PRACTICES AT PACIFIC NORTHWEST LABORATORY. Gulley, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The radiation problems associated with Pu are summarized. Criticality control and Pu fabrication controls are briefly discussed. (M.O.W.)

33552 (CONF-660308, pp 159-68) PLUTONIUM MANAGEMENT AT ARGONNE NATIONAL LABORATORY. Shuck, A. B.; Handwerk, J. H. (Argonne National Lab., Ill.).

Plutonium management involves the control of nuclear hazards, radiological safety, fire hazards, plutonium accountability, economics, and security. A detailed written statement of procedure must be submitted to the Laboratory Director for any operation at ANL that will involve fissionable amounts of plutonium. Such statements are reviewed by a Divisional Criticality Control Representative and by the Criticality Hazards Control Committee. The statements must be approved by the director of the division responsible for the work and by the Laboratory Director before plutonium is released for the work. The radiological safety, fire hazards and plutonium accountability are monitored by area representatives and inspectors of the Technical Services Divisions, but prime responsibility for plutonium management resides with the division responsible for the work. (M.O.W.)

33553 (EUR–2965.e) ENVIRONMENTAL RADIOACTIVITY, ISPRA 1965. de Bortoli, M.; Gaglione, P.; Malvicini, A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 72p. Dep. mn.

Measurements of environmental radioactivity during 1965 by the site survey group are described. Data are given on the concentrations of ^{90}Sr, ^{137}Cs, and other radionuclides in fallout, air, soil, waters, plants, animal bones, and foods. (auth)

33554 (ISO-SA–4) CALCULATED NUCLEAR SAFETY PARAMETERS OF LOW-ENRICHED URANIUM. Ridgway, Kenneth R. (Isochem Inc., Richland, Wash.). May 17, 1966. Contract AT(45-1)-1851. 15p. (CONF-660606–7). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Nuclear Society Meeting, Denver.

Results of a calculational survey are presented on design parameters for new equipment to be used in processing of UO_3 and uranyl nitrate enriched between one and five wt % ^{235}U. It was concluded that the GAMEC-II code used to calculate nuclear parameters can be used to provide close estimates of critical masses or dimensions of low-enrichment U systems. (J.R.D.)

33555 (NP–16094) DISPOSITION AND CONTROL OF URANIUM MILL TAILINGS PILES IN THE COLORADO RIVER BASIN. (Federal Water Pollution Control Administration, Region VIII, Denver, Colo.). Mar. 1966. 83p.

The radioactivity content of uranium mill tailings piles in the Colorado River Basin and their radioactivity water pollution potential were evaluated. A cost analysis of suggested tailings pile control measures at the mills is presented. ^{226}Ra was demonstrated to be the major factor in causing radioactivity increases in tailings-affected streams. It is recommended that: interim measures to prevent erosion and spread of uranium mill tailings be undertaken. All distribution of mill tailings from either nonoperating or operating mills be halted until proper and adequate review procedures can be instituted, and agreements be reached on long-term public and private responsibility for adequate maintenance of the tailing piles. (M.C.G.)

33556 (NP–16124) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 4, Number 4. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Apr. 1966. 42p. Dep. mn.

Results of ^{137}Cs measurements in the Canadian north for the second half of 1965 are presented. The ^{137}Cs concentrations in caribou and reindeer meat and in urine samples from three dietary groups are reported. Fallout monitoring, including analyses of air particulates, precipitation, milk, water, wheat, soil, and human bone, was carried out and results for March, 1966, are given. Radiation monitoring data obtained in March, 1966, near the sites of the Chalk River reactors, the NPD reactor, the CANDU reactor, and the Whiteshell Nuclear Research Establishment Surface water samples, whole milk samples, and air samples were analyzed for ^{89}Sr, ^{90}Sr, ^{137}Cs, and total activity. (M.C.G.)

33557 (ORNL–3969) HEALTH PHYSICS AND SAFETY ANNUAL REPORT FOR 1965. Morgan, K. Z. (Oak Ridge National Lab., Tenn.). July 1966. Contract W-7405-eng-26. 91p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The gaseous and liquid waste releases from the Laboratory were such that the concentration of radioactive materials in the environs was well below the maximum levels recommended by the National Committee on Radiation (NCRP) and Federal Radiation Council (FRC). The average concentration of radioactive materials in the atmosphere at the X-10 site was less than 1% of the maximum permissible for persons residing in the neighborhood of an atomic installation, and the concentration was, as expected, even less at the perimeter of the controlled area. The calculated average concentration of radioactive materials in the Clinch River at the point of entry of White Oak Creek into the River was also less than 1% of the maximum permissible for persons residing in the neighborhood of an atomic energy installation. No employee received an external or internal radiation dose which exceeded the maximum permissible levels recommended by the FRC. The highest whole body dose equivalent received by an employee was about 4.4 rem or 37% of the maximum permissible annual dose. No employee has a cumulative whole body dose which exceeds the recommended maximum permissible dose as based on the age proration formula 5(N-18). There were no cases of internal exposure where the deposition of radioactive materials within the body was estimated to have averaged greater than one-half of a maximum permissible body burden. During 1965, there were 41 unusual occurrences recorded, which is the second lowest number recorded since the present system of reporting unusual occurrences was established in 1960. The 41 occurrences is an increase of 42% over the 29 reported for 1964, the lowest number per year which has been reported, but is about 17% below the five-year average for the year 1961 through 1965. The Laboratory reported 17 disabling injuries during 1965, which was a frequency rate of 2.2. The total number for the past five years (1961–1965) was 56, or an average frequency rate of 1.5. (auth)

33558 (ORNL-NSIC-10) CURRENT NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Buchanan, J. R.; Cross, N. F. (Oak Ridge National Lab., Tenn.). June 1966. Contract W-7405-eng-26. 535p. Dep. mn. CFSTI $6.50 cy, $2.25 mn.

A guide is presented to research and development activities in nuclear safety for the specialists and scientists associated with Nuclear Research and Development contract (NSIC). A summary is presented to describe the purpose, need, and scope of each program. The contracts are grouped into 19 categories as established by NSIC for cataloging nuclear safety information. (J.R.D.)

33559 (ORNL-P-2161) SHIPPING COST COMPARISONS FOR LEAD-, STEEL-, AND URANIUM-SHIELDED CASKS. Shappert, L. B.; Salmon, R. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 8p. (CONF-660532-1). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Atomic Energy Commission Traffic Management Conference, Las Vegas, Nev.

A cost comparison was made of lead-, steel-, and uranium-shielded casks, limited to an empty weight of ~25 tons, that can be shipped by motor freight. Economics of the transportation of these casks are a function of handling, transportation, insurance, and amortization costs. The casks are assumed to be bought by the shipper and amortized at a rate of 15% per year. The greater carrying capacity of the uranium-shielded casks indicated possible competitiveness under specified conditions (cost of fabrication uranium is in the range of $4.00 to $9.00 per pound). (M.C.G.)

33560 (UCRL-16730) A REVIEW OF LIQUID HYDROGEN SAFETY FOR RESEARCH EQUIPMENT. Hernandez, H. P. (Lawrence Radiation Lab., Univ. of California, Berkeley). June 2, 1966. Contract W-7405-eng-48. 25p. (CONF-660605-3). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Cryogenic Engineering Conference, Boulder, Colo.

Over ten years' experience with the use of liquid H_2 in research apparatus related to large particle accelerators is reviewed. The long, continuous experience has provided safety philosophies and design and operational procedures by accelerator laboratories. Effort is made to approach safety through system safety and reliability. Consideration is given to equipment and facilities that make unsafe operation difficult. Many safety problems have been solved but many remain unsolved, particularly in the area of basic assumptions and quantities. (auth)

33561 (VUF-1025) PROJECT DRIBBLE-SALMON EVENT ON-SITE HEALTH AND SAFETY REPORT. Tappan, J. Tell; Moore, William E. (comps.) (Reynolds Electrical and Engineering Co., Mercury, Nev. Radiological Sciences Dept.). Nov. 1965. Contract AT(29-2)-162. 56p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The Salmon Event was detonated at the Atomic Energy Commission's Project Dribble Test Site, Tatum Salt Dome, near Hattiesburg, Mississippi, on October 22, 1964, to test improved instrumentation and explore procedures for detecting underground nuclear detonations. Radiation measurements were recorded during and after the detonation by a remote area monitoring system. After the detonation, radiation monitors equipped with portable radiation detection instruments surveyed the route into surface ground zero before other planned reentries were made. Continuous surveillance was provided while personnel were in the area. Radiological sciences requirements included: recording measurements of gamma dose rates; measurements of radionuclide concentrations in air; measurements of radionuclide concentrations in water; toxic gas and explosive mixture measurements; portable instrument measurements of gamma dose rates; and portable instrument measurements of alpha radiation. Only background radiation measurements were observed from zero time until communication with the cavity was established during postshot drilling operations at a depth greater than 2600 feet. Fifty-two individuals received radiation doses in excess of 100 mrem during the Salmon Event program. The maximum accumulated individual dose was 1065 mrem. (auth)

33562 INVESTIGATION OF THE SEVESO RIVER. NO. 7. MEASUREMENT OF THE RADIOACTIVITY AND AN ANALYSIS OF THE ^{90}Sr AND THE ^{137}Cs CONCENTRATIONS. Cerrai, E.; Triulzi, C. (CISE, Milan). Acqua Ind., No. 37, 27-34(1965). (In Italian). (CISE-516).

A radiochemical analysis was made of samples at various sites of the Seveso River to determine their total β activity and to determine the radioisotopes responsible for the activity. The sampling and processing technique used is described. The experimental results are reported with respect to: weight of dry residue at 150°C; total β activity of the sample including residue from the filtered water and the suspended material; spectroscopy of the γ radiation of sources formed from the residue of the suspended material; and radioactivity from ^{137}Cs and ^{90}Sr. The results are tabulated. It was concluded that the total β activity present in the Seveso is caused partially by potassium and partially by radioactive fallout. The radioactive fallout is composed principally of fission products. (J.S.R.)

33563 MEASUREMENT OF THE PERFORMANCE OF FILM BADGE SERVICES. Barber, Donald E. (Univ. of Michigan, Ann Arbor). Contract PH-86-63-198. Amer. Ind. Hyg. Ass. J., 27: 243-51(May-June 1966).

A film badge performance test has been devised to generate data sufficiently broad in scope to serve as the basis for control limits to be applied in the periodic examination of film badge services. Irradiation procedures, dosimetry, and a measure of film badge accuracy appropriate to the practical use of film badges are discussed. Approximately 2000 film badges were irradiated with various types and energies of radiation. Exposures ranged from 2 mR to 497 R. Private, industrial, and federal suppliers of film badge services helped design the test procedures; submitted badges for exposure, reported exposure interpretations, and assisted in determining provisional performance control limits. (auth)

33564 CONCENTRATION OF ^{137}Cs IN AUSTRALIAN MILK DURING 1965. Bonnyman, J.; Duggleby, J. C.;

Molina-Ramos, J.; Sewell, D. K. B. (Commonwealth X-ray and Radium Lab., Melbourne). Austral. J. Sci., 28: 411-12(May 1966).

Weekly specimens of milk from different cities were combined to form a monthly composite sample for analysis. After the liquid milk had been evaporated and ashed, cesium was separated chemically and subsequently measured by beta counting. The estimated error of measurement was better than ±10%. A general rise in ^{137}Cs levels in precipitation during the second half of 1964 was reflected quite rapidly as an increase in the concentration of ^{137}Cs in milk for Melbourne, Hobart-Launceston, Adelaide, and Perth. This effect was not seen in milk for Brisbane and Sydney. The results suggest that the maximum value for the concentration of ^{137}Cs in milk in Australia, due to all past nuclear weapon tests, was reached in late 1964–early 1965. (P.C.H.)

33565 CONCENTRATION OF ^{137}Cs IN AUSTRALIAN RAINWATER DURING 1964 AND 1965. Alsop, R. J. L.; Bonnyman, J.; Duggleby, J. C.; Molina-Ramos, J.; Sewell, D. K. B. (Commonwealth X-ray and Radium Lab., Melbourne). Austral. J. Sci., 28: 413-17(May 1966).

Descriptions of measurement techniques and results for ^{137}Cs deposition in Australia during 1964 and 1965 are reported. It was found that the ^{137}Cs deposition each month at any station was closely related to the monthly rainfall total at that station. The dependence of ^{137}Cs deposition on the rainfall was examined, and the variations in deposition that would be expected if the same amount of rain fell each month of the year were deduced. The results indicated a maximum departure from normalized deposition in the spring of 1964 and a lower maximum in the spring of 1965. In the absence of further nuclear weapons tests, it is expected that the general downward trend of ^{137}Cs deposition will continue. (P.C.H.)

33566 ^{90}Sr IN THE AUSTRALIAN ENVIRONMENT DURING 1964. Fletcher, W. (United Kingdom Atomic Energy Authority, Capenhurst Works, Eng.); Moroney, J. R.; Gibbs, W. J.; Stevens, D. J.; Titterton, E. W. Austral. J. Sci., 28: 417-24(May 1966).

The mean annual deposition of ^{90}Sr in precipitation at eight monitoring sites in Australia remained in the region of 1 mC/km^2/annum from 1958 to 1962. An increase in ^{90}Sr fallout in 1963 continued through 1964 but was less evident during the first 6 months of 1965; the mean annual fallout rates for the three periods were 1.3, 2.0, and about 1.5 mC/km^2/annum, respectively. The analysis of foodstuffs surveyed during 1964 provided a basis for estimating the mean daily per capita intake of ^{90}Sr in diet in Australia, and thus the mean ratio, $^{90}Sr/Ca$, in total diet for the year. ^{90}Sr was also measured in soils, precipitation, and human bone. Data are tabulated. (P.C.H.)

33567 ORGANIZATION OF A CONTROL OF RADIOACTIVE POLLUTION OF MILK: CASE OF ISOTOPES WITH LONG PERIODS. Michon, G. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Bull. Acad. Vet. France, 36: 463-5(June 1963). (In French).

Among the radioisotopes of long half life deposited as fallout, the nuclides of most concern to the public health hygienist are ^{90}Sr and ^{137}Cs. In the equilibrium state, 0.2% of the Sr quantity ingested by the cow is excreted in the milk; this value reaches 4% in the ewe. Three to 4% of the total Cs ingested by the cow is excreted in the milk. Because of its physical-chemical properties, Cs is largely retained in the soil and does not reach a great concentration in plants, so that ^{90}Sr poses the greater problem to health. The following suggestions should be incorporated into a control mechanism for these isotopes. Sampling should be representative of regional or national production; sampling points should be representative of a climatically, pedologically, and if possible zootechnically homogeneous zone; frequency of sampling should be as great as possible, at least monthly; analyses should include not only elemental data but data for each radioactive isotope to allow proper interpretation for health purposes. (BBB)

33568 HEALTH PHYSICS. Dutrannois, J. (CERN, Geneva). CERN Cour., 6: 45-9(Mar. 1966).

Developments achieved by the Health Physics Group at CERN since 1961 are discussed. The duties of the Group include monitoring personnel to ensure that radiation doses are kept to a minimum and to monitor working areas around the accelerators at CERN. Some of the information obtained is reported. (P.C.H.)

33569 RADIOACTIVE POLLUTION OF GAS ENVIRONMENTS. Blum, Jacques M. Energ. Nucl., 8: 141-2(Mar. Apr. 1966). (In French).

A bibliography of the recent publications on the prevalence, dangers, and the control of atmospheric radioactivity is presented. (48 references.) (J.S.R.)

33570 HYGIENIC PROBLEMS IN ORGANIZATION OF THE WORKING SITES OF HOT CHAMBER OPERATORS. Kopaev, V. V. Gig. Sanit., No. 3, 107-10(Mar. 1966). (In Russian).

The type of operation and of remote-controlled equipment should be considered in designing a hot cell, because these factors determine the working position of the operator and the difficulty of carrying out the work. A sitting position limits the mobility of the operator and makes it difficult to carry out the work with manipulators. The viewing system is usually at the wrong angle and the manipulator controls are more difficult to reach from a sitting position. A standing position is preferred in working with hot-cell manipulators. The normal width of the working zone is about 800 mm with a maximum reach of about double this value. Tools and jigs should be properly arranged in the cell to avoid uncomfortable working positions. (TTT)

33571 THE MEANINGS OF "FIRST COLLISION DOSE". Attix, Frank H. (Naval Research Lab., Washington, D. C.). Health Phys., 12: 793-9(June 1966).

Three different interpretations of the term first collision dose are discussed. These are: first collision dose = absorbed dose in an isolated small mass; first collision dose = that part of the absorbed dose contributed by "primary" radiation only, in a small mass located anywhere; and, first collision dose = kerma. The fact that the term "kerma" cannot be indiscriminately substituted wherever first collision dose is now employed is stressed. (P.C.H.)

33572 IN SITU MEASUREMENT OF THE EFFICIENCY OF ABSOLUTE FILTERS. Abraham, P. (Atomic Energy Establishment, Trombay, India). Health Phys., 12: 861-2 (June 1966).

Measurements of the efficiency of filters were made by assuming different sampling efficiencies for the downstream sampling filter and ~100% for the upstream one. When the efficiency of the sampling filter paper was 10% downstream of the absolute filter, the efficiency of the absolute filter for retention of activity was found to be 99.77%. (P.C.H.)

33573 DEBRIS FROM THE CHINESE ATOMIC TEST OF MAY 1965 INTERCEPTED OVER THE NORTHWESTERN UNITED STATES. Gudiksen, P. H.; Chakravarti, D.; Fairhall, A. W.; Young, J. A. (Univ. of Washington, Seattle). Contract AT(45-1)-1776. Health Phys., 12: 862-3(June 1966).

After the single atmospheric nuclear detonation over China on May 14, 1965, debris intercepted on May 18, 1965, over Spokane, Washington, was found to contain ^{90}Sr, ^{95}Zr, ^{103}Ru, ^{106}Ru, ^{131}I, ^{140}Ba, ^{144}Ce, and ^{14}C. The data obtained closely follow the mass yield curve for thermal neutron-induced fission of ^{235}U. The debris did not seem to be appreciably fractionated, which may be indicative of an air burst, as was earlier reported. Measurement of the temperature profile during the collection flight indicated that the tropopause was located at 37,000 ft. (P.C.H.)

33574 TOTAL-BODY BURDEN OF ^{137}Cs IN JAPANESE IN 1964 AS ASSESSED BY BLOOD ANALYSIS. Yama-

gata, N.; Iinuma, T. A. (Inst. of Public Health, Tokyo. National Inst. of Radiological Sciences, Chiba, Japan). Health Phys., 12: 901-7(July 1966).

Radiochemical determination of cesium-137 in pooled whole blood samples obtained from blood banks throughout Japan was made. The average body burden for April to December 1964 is approximately 200 pC/kg body weight as assessed on the basis of parallel determinations of the blood concentration and the body burden by use of a human counter on laboratory personnel. In a near equilibrium condition between the diet and the body, 1.3 per cent of the total-body cesium-137 is estimated to be located in blood. (auth)

33575 GAMMA-EMITTING FALLOUT NUCLIDES IN THE NETHERLANDS DIET. de Ruyter, A. W.; Aten, A. H. W. Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Health Phys., 12: 909-15(July 1966).

A low-background gamma-counter has been constructed for the measurement of some radionuclides in the human diet in the Netherlands in 1964. The quantities of the nuclides consumed daily are determined from their concentration in urine and feces. In urine K and ^{137}Cs are measured, in feces K, ^{137}Cs, ^{54}Mn, and ^{144}Ce. To explain the excretion of these nuclides the same isotopes are determined in a series of foodstuffs. The activities occurring in these foodstuffs seem to be in rough agreement with the quantities excreted. Apart from the nuclides mentioned vegetables also contain some other activities, two of which have been recognized as ^{7}Be and ^{125}Sb. (auth)

33576 UNUSUAL FILM BADGE EXPOSURE. Stone, G. F. (Tennessee Valley Authority, Oak Ridge). Health Phys., 12: 967-8(July 1966).

Storage of a personnel monitoring film badge overnight in a drawer that contained an old World War I infantry compass resulted in evidence of significant penetrating radiation exposure. The assembled compass read 6 mrad/hr at contact with a GM survey meter. Results of a γ scan of the compass showed peaks consistent with Ra in equilibrium with its daughters. Based on comparison with a Ra standard it was estimated that the compass contained about 7.3 μg of Ra in a luminescent coating. (C.H.)

33577 BIOLOGICAL MONITORING FOR ^{131}I FOLLOWING RADIOACTIVE CONTAMINATING EVENTS. Ward, Gerald M. (Colorado State Univ., Fort Collins). Health Phys., 12: 981-2(July 1966).

In the event of nuclear contamination of agricultural lands it is recommended that lactating dairy cattle be removed from pasture and fed stored food until ^{131}I activity on plants has reached acceptable levels. Estimations of acceptable ^{131}I activity require the frequent collection and analysis of forage samples and calculations of ^{131}I half-life in cows. It is suggested that a number of troublesome problems are eliminated by leaving a few cows on the pasture and basing ^{131}I estimates on milk data rather than on forage samples. (C.H.)

33578 ENVIRONMENTAL SURVEILLANCE AT THE NATIONAL REACTOR TESTING STATION. Horan, John R.; Paas, Herman J. Jr. (Atomic Energy Commission, Idaho Falls, Idaho). Health Phys., 12: 1039-45(Aug. 1966).

Influences guiding the origin, development, and refinement of a systematic environmental surveillance program for a multiple-reactor complex are presented. Program design differs in that it incorporates the knowledge of planned fission product releases associated with destructive testing. Capabilities for early warning and prompt automated evaluation of integrated doses for the major exposure pathways to man are described. In recent years trends away from the early concepts of extensive and detailed surveillance have produced a minimum routine monitoring effort that provides direction of emphasis into specific indices of environmental exposure. Unique aspects of the present day capabilities of the program include: a dynamic research program supported by the USWB and USGS to provide detailed knowledge of the capacity of the environment for the safe dissipation of radioactive or other toxic effluents; a sophisticated radiation telemetering system for monitoring population and agricultural centers; census data maintained on a current basis to provide prompt and accurate information on the residential and grazing populations at risk, e.g., age distribution, land use, milk production, and localized milk consumption. (auth)

33579 CIVIL DEFENSE AND THE VETERINARIAN. Kerr, James W. (Office of Civil Defense, Washington, D. C.). J. Amer. Vet. Med. Ass., 147: 1522-6(Dec. 15, 1965).

Recent developments in the fallout shelter system, as a major component of civil defense, are reviewed, and the role of the veterinarian in civil defense is outlined. Duties of the veterinarian in event of a thermonuclear attack would center around public health activities, including zoonosis and food sanitation. This would probably take priority over the individual direct medical attention to animals. If the situation were critical enough, the treatment of human casualties would take precedence over everything. The treatment of human casualties by nonphysicians is considered. Veterinarians might be called upon to perform so-called physician functions. However, it is emphasized that their involvement with human casualties would in most instances be limited and often under direct guidance of a physician. In many cases, their services would be more applicable in other areas more directly related to their professional training. If the emergency situation demands that veterinarians become involved with human medical problems, it would most likely be for a short time only, after which their services in the rebuilding of the community would be an indispensable contribution. (TCO)

33580 REMOVAL OF RADIOSTRONTIUM FROM MILK WITH TRICALCIUM PHOSPHATE AND RESULTING CHANGES IN MILK COMPOSITION. Edmondson, L. F. (Dept. of Agriculture, Washington, D. C.); Landgrebe, A. R.; Sadler, A. M.; Walter, H. E. J. Dairy Sci., 48: 1597-1601 (Dec. 1965).

The effectiveness of tricalcium phosphate in removing ^{85}Sr from milk and the effects of the procedure on milk composition were studied. The phosphate was added to milk at the rate of 80 grams per liter and the resulting precipitate, containing ^{85}Sr, was removed by centrifugation. Heating milk to 70°C for 30 min, immediately following addition of phosphate, resulted in removal of 85% of the ^{85}Sr. When the pH of milk was adjusted to 5.4 with H_3PO_4, then to 8.2 with KOH before adding phosphate, 90% removal of ^{85}Sr was obtained by heating to 70°C for only 3 min. When phosphated milk (pH 6.6) was stirred at 5°C for 24 hr, only 60% of the ^{85}Sr was removed. (Public Health Abstr.)

33581 FIELD STUDIES OF SPECIFIC RADIONUCLIDES IN FRESH WATER. Porcella, D. B.; Friend, A. G. (Northeastern Radiological Health Lab., Winchester, Mass.). J. Water Pollut. Contr. Federation, 38: 102-10(Jan. 1966).

Higher concentrations of ^{90}Sr, ^{137}Cs, and chemically similar radioisotopes are found in fish in Lower Three Runs than in fish in the Clinch River, Tenn. Cesium-137 is adsorbed on illitic clays in the Clinch River. The (^{90}Sr/(Ca + Sr)) ratio, 10 times greater in Lower Three Runs than in the Clinch River, caused ^{90}Sr levels 5.1 times greater in bones of Lower Three Runs largemouth bass. Cesium-137 concentration was 45 times greater in Lower Three Runs fish flesh than in Clinch River fish flesh. Differences in species, tissue, and life history were factors in influencing radioisotope levels in individual fish. (Public Health Abstr.)

33582 SHIPPING IRRADIATED NUCLEAR FUEL SAFELY. Langhaar, John W.; Braidech, Mathew M. Mag. Stand., 36: 279-81(Sept. 1965).

Preventing public exposure to ionizing radiation hazards in the event that a vehicle carrying spent and irradiated fuel from a nuclear reactor to a reprocessing site is involved in an accident in passing through a populated area is the purpose of a new American Standard. Materials present in such fuel can be harmful if inhaled or ingested

or if they expose the body to external radiation. Shipping containers must therefore be designed to contain the fuel components and to provide radiation shielding around the fuel under severe accident conditions. In addition, they must remove the heat generated by fission products and prevent possible accidental rearrangement of the fuel that might result in an uncontrolled nuclear chain reaction. The recommendations in American Standard Guide for Design and Operation of Shipping Containers for Irradiated Solid Fuel from Nuclear Reactors, N5.3–1964, are intended to provide such safeguards. These recommendations include containers for off-plant shipment of irradiated fuel by customary land transportation or by both land and water carriers. Air shipment and shipment entirely by water are excluded. (Public Health Abstr.)

33583 MISSION OF THE PHARMACIST IN NUCLEAR DISASTER. Braucher, Charles L. (Southwestern State Coll., Weatherford, Okla.). Military Med., 131: 234-44 (Mar. 1966).

The role of the pharmacist in caring for casualties of thermonuclear war is outlined and an estimate is made of the extent to which medical and pharmaceutical services would be disrupted by detonation of thermonuclear weapons in and near Oklahoma City. The physician and pharmacist survival rates would be about the same in an air explosion of both low and high-yield nuclear weapons over the center of Oklahoma City. With a 20-kiloton weapon the survival rate would approximate 90% while a 20-megaton weapon would allow a survival rate of about 0.5%. A survival differential would occur after detonation of a 1-megaton weapon over the Oklahoma City center, whereby ~19.5% of the physicians and 44.7% of the pharmacists would survive. In the event of a 20-megaton explosion over the center of Tinker Air Force Base, the pharmacist survival rate (37.1%) would be more than triple that of the physician (11.9%). These survival rate differentials are caused by the scattered distribution pattern of pharmacists compared with the centrally grouped distribution pattern of physicians throughout the Oklahoma City metropolitan area. Medical service supplied by physicians would be seriously disrupted or almost completely curtailed, depending upon an enemy's choice of nuclear weapon and its target. This study reveals that at least one paramedical group, the pharmacists, because of their greater dispersion generally have a higher survival rate than physicians. This means that the pharmacist, under certain conditions, could more than double the postattack available medical manpower when compared with physicians alone. The pharmacist's primary mission in nuclear disaster would be a life-saving mission. Consequently, he must be prepared to assume emergency duties which would ordinarily be performed by physicians. A pilot training program should be established for pharmacists in advanced emergency medical procedures. (BBB)

33584 SOME PROBLEMS IN ENVIRONMENTAL CONTAMINATION. Tajima, Eizo (St. Paul's Univ., Japan). Nippon Genshiryoku Gakkaishi, 8: 209-14(Apr. 1966).

Environmental contamination is classified as being due to industry, cities (factors associated with the expansion of cities such as car exhausts), and governments. Radiation from reactors comes under the category of industrial contamination while fallout comes under the third category. The contamination that can result from nuclear establishments differs from other types of contamination in that the potential hazard is very great, the problem has been realized from the earliest installations, and the contamination has a long lasting trait. There is considerable difference in the way contamination due to reactors and to fallout is handled. As far as Japan is concerned, the latter source of contamination is considered not permissible. The contamination from nuclear plants can be disseminated through the atmosphere, ground, and seas. The types of contamination as well as the levels of exposure are discussed. One of the criteria for the selection of a nuclear plant site is low population distribution. (TTT)

33585 ^{137}Cs IN LITTER AND UNDERSTORY VEGETATION. Rickard, W. H. (Battelle-Northwest, Richland, Wash.). Northwest Sci., 40: 25-30(Feb. 1966). (BNWL-SA–215).

Cesium-137 derived from world-wide fallout was measured in the understory vegetation and leaf litter of 3 different mature conifer stands in the Cascade Mountains of Washington in September 1964. The ^{137}Cs concentration of understory shrubs was more or less similar among the 3 stands. More ^{137}Cs, however, was present in the understory in the hemlock stand when expressed as ^{137}Cs/m^2 of ground because of the more luxuriant understory growth in this habitat. Cesium-137 in leaf litter was most abundant in a fir stand near the mountain summit. The leaf litter of a hemlock stand in a high-precipitation region west of the mountains had higher ^{137}Cs concentrations than did the litter from a ponderosa pine stand from a lower-precipitation region east of the mountains. (Public Health Abstr.)

33586 RADIOLOGICAL HEALTH DATA. Volume 6, Number 9. Public Health Service, Washington, D. C., Sept. 1965. 58p. GPO $0.50.

Data are presented on radioactivity due to fallout in samples of air, milk, precipitation, surface waters, and water supplies collected throughout the United States during 1965. Data are also included on the content of ^{90}Sr in average diets in representative cities, and the radioactivity in air samples collected in Pan America and precipitation sampled in Canada in 1964. Environmental levels of radioactivity at Argonne National Lab., Lemont, Ill., Atomics International, Canoga Park, Calif., and the National Reactor Testing Station, Idaho Falls, Idaho, during the last half of 1964 are reported. Two underground nuclear tests were announced by the Atomic Energy Commission in August, 1965. (C.H.)

For abstracts of individual sections see: 33587 and 33588.

33587 DIETARY INTAKES AND BODY BURDENS OF ^{137}Cs. Rivera, Joseph (U. S. Atomic Energy Commission, New York). Radiol. Health Data, 6: 504-6(Sept. 1965).

Cesium-137 content in food purchased in New York City, Chicago, and San Francisco during the last quarter of 1964 were determined radiochemically. The data were used to calculate the body burdens resulting from the ingestion of ^{137}Cs. (C.H.)

33588 ^{90}Sr in CANADIAN WHEAT FROM THE 1963 CROP YEAR. Samuels, E. R. (Dept. of National Health and Welfare, Ottawa). Radiol. Health Data, 6: 506-8 (Sept. 1965).

Data are presented on the content of ^{90}Sr in Canadian hard red spring wheat grown and harvested during 1963. The average concentration of ^{90}Sr in wheat grown during 1963 was increased by a factor of about 3 over that observed in 1962. (C.H.)

33589 RADIOLOGICAL HEALTH DATA. Volume 6, Number 10. Public Health Service, Washington, D. C., Oct. 1965. 74p. GPO $0.50.

Data are presented on radioactivity due to fallout in samples of air, precipitation, milk, foods, institutional diets, surface waters, and water supplies collected throughout the U. S. during the first half of 1965. Data are included on the content of ^{90}Sr in surface waters sampled from Oct. 1964 through March 1965 and the radioactivity levels in drinking water supplies of 139 municipalities in 1962. Environmental levels of radioactivity at Bettis Atomic Power Lab., Pittsburgh, Pa., Feed Materials Production Center, Fernald, Ohio, Knolls Atomic Power Lab., Schenectady, N. Y., and Combustion Engineering, Inc., Windsor, Conn., during the last half of 1964 are reported. Two underground nuclear tests were announced by the Atomic Energy Commision during Sept. 1965. (C.H.)

For abstracts of individual sections see: 32924, and 33590–33593.

33590 RADIOLOGICAL SURVEY OF THE LOWER COLUMBIA RIVER IN OREGON, AUGUST 1963–JULY 1964. Toombs, George L. Radiol. Health Data, 6: 563-8(Oct. 1965).

Results are reported from a radiobiological survey of the lower Columbia River in Oregon and the Oregon sea coast near the mouth of the Columbia River in 1963 and 1964. Water, sediment, and algae samples were γ scanned in their original state and the edible portions of crab, clams, and oyster samples were counted with normal tissue liquid. Gross γ and β counts of samples of Columbia River waters were made. The level of radioactivity in all samples was well below recommended maximum permissible concentrations. (C.H.)

33591 ^{131}I IN BOVINE THYROIDS, OCTOBER–DECEMBER 1964. Baratta, Edmond J. (Public Health Service, Winchester, Mass.); Williams, Edward R.; Murray, George Radiol. Health Data, 6: 569-74(Oct. 1965).

Data are presented on the content of ^{131}I in bovine thyroid glands collected at slaughter houses throughout the U. S. during Oct. and Dec. 1964. A comparison of results with milk data indicates that thyroid analysis is an extremely sensitive method for the detection of environmental ^{131}I. (C.H.)

33592 ^{90}Sr IN HUMAN VERTEBRAE, 1964 RESULTS. Rivera, Joseph (U. S. Atomic Energy Commission, New York). Radiol. Health Data, 6: 575-7(Oct. 1965).

Data are presented on the ^{90}Sr content in samples of human bones collected at representative U. S. cities during 1964. The agreement between calculated and observed ^{90}Sr/Ca ratios in adult vertebrae indicate the validity of bone sampling as an indication of levels of environmental ^{90}Sr. (C.H.)

33593 PROJECTED VALUES OF ^{137}Cs BODY BURDENS IN ANAKTUVUK PASS ESKIMOS FOR THE SUMMER OF 1965, BASED ON FINDINGS IN CARIBOU MUSCLE. Coleman, James R. (Public Health Service, Washington, D. C.). Radiol. Health Data, 6: 578-82(Oct. 1965).

Relatively high levels of fallout radionuclides in arctic ecosystems were discovered in 1959 and confirmed by whole-body counting of ^{137}Cs in Alaskan Eskimos in 1962. A method is described for predicting ^{137}Cs values in Eskimos based on the ^{137}Cs content in caribou flesh. Data are included on the ^{137}Cs content in caribou flesh and whole-body counting data for a group of 21 adult Anaktuvuk Pass inhabitants for the summer of 1965. The method evaluates available data in terms of simplified considerations and is not intended to define basic biological parameters or ecological situations. (C.H.)

33594 RADIOLOGICAL HEALTH DATA AND REPORTS. Volume 7, Number 4. Public Health Service, Washington, D. C., Apr. 1966. 47p. GPO $0.50.

Data are presented on radioactivity due to fallout in samples of milk, surface waters, surface air, and precipitation collected throughout the United States during 1965. Data are included on some samples collected at selected sites in Canada and Pan America and on the ^{90}Sr content in bones of persons dying through 1964. Results of environmental radiation monitoring at Bettis Atomic Power Lab., Pittsburgh, Feed Materials Production Center, Fernald, Ohio, Knolls Atomic Power Lab., Schenectady, N. Y., and Combustion Engineering, Inc., Windsor, Conn., during the first half of 1965 are included. Data are summarized on five underground nuclear tests announced by the Atomic Energy Commission in March, 1966. (C.H.)

For abstracts of individual sections see: 33530 and 33595.

33595 COMPARISON OF ^{90}Sr, ^{131}I, AND ^{137}Cs IN MILK AND MILK PRODUCTS. Reavey, Thomas C.; Baratta, Edmond J. (Northeastern Radiological Health Lab., Winchester, Mass.). Radiol. Health Data Rep., 7: 215-18(Apr. 1966).

Distribution of strontium-90, iodine-131, and cesium-137 in series of whole milk and products representing the original milk in each series was studied. The radionuclide most affected by processing was iodine-131, which in the preparation of evaporated skim milk and nonfat dry milk was reduced to as little as 30 percent and 8 percent of the original fluid milk iodine-131 contents, respectively. While strontium-90 and cesium-137 contents of milk and milk products did not appear markedly changed by processing, cottage cheese, heavy cream, and butter retained the smallest concentrations of these radionuclides. (auth)

33596 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY, NO. 41, APRIL-JUNE, 1965. Taiki Hoshano Kansoku Seiseki, No. 41, 1-65(Apr.-June 1965).

Data on radioactivity in rain and airborne dusts in different cities in Japan are tabulated. (P.C.H.)

33597 CALCULATED NUCLEAR-SAFETY PARAMETERS OF LOW-ENRICHED URANIUM. Ridgway, Kenneth R. (Isochem, Inc., Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 134-5(June 1966).

33598 NEW COURSE IN INDUSTRIAL SAFETY IN NUCLEAR PLANTS. Jankowski, F. J. (Rutgers Univ., New Brunswick, N. J.). Trans. Amer. Nucl. Soc., 9: 209-10(June 1966).

33599 ZASHCHITNOE OBORUDOVANIE, SREDSTVA INDIVIDUAL'NOI ZASHCHITY I ZASHCHITNYE MATERIALY DLYA RABOTY PREDPOLAGAEMYE K REALIZATSHII V 1965 G. KATALOG. (Shielding Equipment for Individual Protection and Protective Materials for Work with Radioactive Materials, Planned for Production in 1965. Catalog). Moscow, Atomizdat, 1964. 190p.

Detailed descriptions, including dimensions, weight, performance parameters, and price, are given of furniture and remote-control equipment, shielding and filtering facilities, storage and transportation containers, and protective clothing for the handling of radioactive materials in laboratories and field work. (M.J.T.)

INSTRUMENTATION

General

33600 (BNL-10308) PULSE SHAPE DISCRIMINATOR. Chase, R. L.; Rogers, L. C. (Brookhaven National Lab., Upton, N. Y.). May 25, 1966. Contract AT(30-2)-Gen-16. 9p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A pulse shape discriminator is described which accepts 0 to 10 v double delay line differentiated pulses from a linear amplifier at its input and indirectly measures the width of the pulse from T_0 to baseline crossover. If the measured width meets a preset specification the circuit generates an output gate. (B.G.D.)

33601 (DP-MS-66-5) SOLID-STATE LOGARITHMIC CONVERTER. Byrd, J. S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar. 31, 1966. Contract AT(07-2)-1. 13p. (CONF-660408-4). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Instrument Society of America, Southeastern Conference and Exhibit, Augusta, Ga.

A method of logarithmic conversion of current to voltage using the short-circuit collector current and the emitter-base voltage characteristics of a silicon transistor is described. Circuits designed to measure picoamperes for nuclear instruments are analyzed, and general design considerations for the converter circuit are discussed. (auth)

33602 (EUR-2969.d) METHODE FUER DIE AUSWAHL DER TRAEGERFREQUENZEN IM DATRAC-SYSTEM (DATRAC: DATENUEBERTRAGUNG UEBER KABEL). (Method for the Choice of Carrier Frequencies in the DATRAC System (DATRAC: DAta TRAnsmission via Cable)). Becker, W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). June 1966. 20p. Dep. mn.

Some basic technical view-points concerning a frequency multiplex system for data transmission over short distances (e.g., 1 km) are dealt with. For this system it is not of main importance to use the theoretically possible information flux admitted by the given transmission means (e.g., coaxial cable). In order to keep the lay-out of the system as simple as possible for the provided application (on-line computer operation, interconnection of two laboratories of the reactor center, etc.) frequency mixers in the receiver were avoided. Thus the channel selection filters are directly tuned to the corresponding channel center frequencies. Distinction is made between two kinds of parallel systems, which are exclusively concerned: (1) systems, where the time response of the filters is the same on all channels, and (2) systems, where the relative channel width is the same for all channels. A simple procedure to fix the channel center frequencies is described considering the transmission speed, the safety margin from the response time and the possible interference by harmonics or first order mixed frequencies, simultaneously trying to put the overall band of transmission in its frequency range as low as possible for reasons of attenuation and frequency stability. Examples are given, and it is referred to the factors to be considered with a simultaneous switch-through of all receiver channels, in order to impede transients. (auth)

33603 (LA-3474) TIME DOMAIN REFLECTOMETRY FOR LIQUID HYDROGEN LEVEL DETECTION. Willis, Walter L.; Taylor, James F. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Feb. 1, 1966. Contract W-7405-eng-36. 7p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Capacitance liquid level gauges are typically high impedance devices and are disturbed by radiation induced shunting. A commercial transmission line impedance measuring system can be adapted to liquid level gauging. The low impedance of such a system makes it radiation tolerant. (auth)

33604 (ORNL-P-2179) DILATOMETER FOR MEASURING AXIAL DISPLACEMENT OF FUEL DURING IRRADIATION. McQuilkin, F. R.; McLean, T. L.; DeCarlo, V. A.; Senn, R. L. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 5p. (CONF-660511-6). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Symposium on Capsule Irradiation Experiments, Pleasanton, Calif.

Axial displacement of UO_2 fuel pellets during irradiation was measured with a dilatometer employing a commercial pneumatic linear motion transducer. A bellows sealed push-rod, coupling the fuel stack to the transducer, provided a unique arrangement for penetrating the fuel encapsulating can. The dilatometer is described. (M.O.W.)

33605 (UCRL-14766) IN-PILE CALORIMETRY. Parker, Robert; Eagan, James (Lawrence Radiation Lab., Univ. of California, Livermore). Apr. 22, 1966. Contract W-7405-eng-48. 15p. (CONF-660511-8). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Symposium on Capsule Irradiation Experiments, Pleasanton, Calif.

An experiment is proposed in which capacitor pulse heating techniques would be used to determine in-pile specific heat data for various materials of interest in reactor design as a function of exposure to integrated neutron flux. The pulse heating method is a relatively new technique which uses the electric discharge of a known amount of energy stored in a capacitor bank through a given sample to rapidly (30 μsec) heat it. By measuring the temperature rise and knowing the energy stored, the specific heat of conductors may be computed. Among the many advantages associated with this technique is the fact that this entire operation may be performed remotely and repeatedly over long time intervals with good precision. Hence, it offers the unique opportunity of providing data on specimens subjected to a neutron flux (5×10^{13} n/cm^2 sec) without having to remove the specimen from the flux, as would normally be the case with more conventional calorimetric test methods. The features of the capsule design are outlined. Detailed capsule sketches and electric bus bars are shown in the proposal, as well as a list of material and total integrated neutron flux exposures that the materials will experience. Analytical expressions governing the electrical pulse heating method are derived. In addition, the test procedure is outlined. (B.G.D.)

33606 PHYSICAL CHARACTERISTICS OF TRITIUM ION GENERATORS. Eichmeier, J.; Buektas, U. (Technische Hochschule, Munich). Elektromedizin, 10: 179-88(Oct. 1965). (In German).

Use of ^{3}H ion generators for biological and medical applications is reviewed and theoretical aspects of ion formation are considered. The usual type generator consists of zirconium foil to which ^{3}H is adsorbed. The β ray emitted interacts with air molecules to form positive and negative ions. Tritium ion generators are examined with respect to their physical properties. The mean β ray energy calculated from the energy distribution curve of the emitted β rays is 3.5 kev. The maximum and mean range of the β rays, calculated by means of the Thomson-Whiddington equation, are 0.67 cm and 0.17 cm respectively. The γ radiation measured in front of the source is compared with the background at a distance of some centimeters. At this distance, any radiation hazard is practically eliminated. From the mean value of the β-ray energy the specific ion increment, and from this the useful activity of various tritium ion sources, was calculated. By flow and concentration measurements, radiation diagrams were plotted for the same sources, and the errors involved in such measurements are discussed. (BBB)

33607 BROAD-LINE NUCLEAR MAGNETIC RESONANCE APPARATUS AND ITS APPLICATIONS. Shimoji, Sadao; Nakamori, Satotsugu (Mitsubishi Electric Manufacturing Co., Ltd., Tokyo). Mitsubishi Denki Giho, 40: 411-17(Feb. 1966). (In Japanese).

A broad line NMR apparatus has been built. Robinson, Pound-Watkins, and Knight types are jointly used for a signal detector to cover the oscillation level of a few mv ~ 10v. Measurement is made at liquid helium temperature and any point between liquid nitrogen temperature and 200°C. The maximum field intensity of the magnet is 16,000 Oe, the uniformity 1×10^{-5}, and the stability 3×10^{-6}. As applications, proton resonance signals in hydrated gypsum and unsaturated polyester and also ^{93}Nb resonance signals in Nb metallic powder have been observed. The hydrated gysum is used for testing the sensitivity and the fidelity of the apparatus. In the unsaturated polyester, separation of broad and narrow components in an amorphous state have been observed. Also in superconducting Nb, broadening of the line, considered due to the distribution of the inner field, has been surveyed. (auth)

33608 APPLICATIONS OF THE SPARK-IMAGING CAMERA. Horwitz, Norman; Lofstrom, James E.; Forsaith, Ann L. (William Beaumont Hospital, Royal Oak, Mich.). Trans. Amer. Nucl. Soc., 9: 76(June 1966).

33609 DEVELOPMENT OF RESISTANCE-TYPE LIQUID-METAL LEVEL ELEMENTS. Briggs, N. H.; Greene, G. W.; Hyland, R. F. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 318-19(June 1966).

33610 DILATOMETER FOR MEASURING AXIAL DISPLACEMENT OF FUEL DURING IRRADIATION. McQuilkin, F. R.; De Carlo, V. A.; McLean, T. L.; Senn, R. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 319-20(June 1966).

33611 MICRO-THERMOBALANCE FOR THE ANALYSIS OF IRRADIATED FUELS. Lyon, W. L. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 9: 320-1(June 1966).

33612 INFLUENCE OF PENETRATION OF ELECTRONS INTO A SOLID BODY ON THE HEATING OF ITS SURFACE BY PULSED ELECTRON BOMBARDMENT. Deniskin, Yu. D. (Moscow Power Engineering Inst.). Zh. Tekh. Fiz., 36: 508-10(Mar. 1966). (In Russian).

The temperature rise at the surface of a body due to bombardment by a short pulse of electrons is calculated taking into account the fact that the electrons penetrate into the target and deliver some of their heat below the surface. The effect of electron penetration on the surface temperature rise is significant when the electron penetration depth is comparable with the depth reached as a result of conduction during the pulse by the heat delivered at the surface. The calculation was undertaken because this condition obtains in some modern high-power high-voltage pulsed electronic equipment. The calculation is straightforward. It is found that the true temperature rise is given by the expression TG, where T is the temperature rise calculated on the assumption that all the heat is delivered at the surface and G is a correction factor less than unity that depends both on the parameter $d/(ct)^{1/2}$, where d is the mean electron penetration depth, c is the thermal conductivity, and t is the duration of the pulse, and on the form of the function giving the fraction of its energy that the electron delivers to the target as heat at different depths below the surface. The factor G was calculated numerically as a function of $d/(ct)^{1/2}$ for different assumptions concerning the distribution function, including those proposed previously, and the results are presented graphically. As a numerical example it is noted that according to current data on electron penetration depths, the factor G for one microsecond pulse on copper is approximately 0.975 for 20 kev electrons and 0.26 for 200 kev electrons. (ATD)

33613 RADIOACTIVE RADIATION TRANSDUCER DEVICE FOR MEASURING VARIABLE CONDITIONS. Black, Robert E. (to General Motors Corp.). U. S. Patent 3,254,211. May 31, 1966. Filed Dec. 11, 1961.

A radiation transducer for a measuring instrument within a housing includes a beta source within the housing and a target within the housing spaced from the source for producing x rays upon bombardment by beta particles. A space between the source and the target is filled with a homogenous beta absorbing material, and the space can be varied to vary the amount of beta absorbing material to modulate the beta particles and thus to modulate the x-ray production. An x-ray detector is located outside the housing for measuring the intensity of the x rays passing through the housing, and the detector is a function of the spacing between the source and the target. (B.L.M.)

33614 NUCLEAR BLAST DETECTOR AND ALARM SYSTEM. Finlay, Joseph M.; Price, Charles D. (to Mosler Safe Co.). U. S. Patent 3,254,219. May 31, 1966. Filed Jan. 7, 1963.

In a nuclear explosion protection system, including a primary blast protective device and at least one secondary protective device, apparatus is provided for operating both devices in response to a nuclear explosion. The operation of the primary device is time critical, and the secondary device is substantially less time critical but is less freely reversible in operation once actuated. A sensor responsive to radiant energy is provided to produce an electrical output corresponding in form and amplitude to the radiant energy. The electrical circuitry is such that the devices can be operated separately, and the circuit means responsive to the initial radiant energy pulse of the nuclear explosion operates the primary device but not the secondary device. Circuit means responsive to the output from the sensor corresponding to the second pulse of a nuclear explosion actuates the secondary device. Provision is made for returning the primary device to its original status if an electrical signal corresponding to the second pulse of the nuclear explosion is not supplied to the sensor within a pre-established time interval following a signal from the sensor corresponding to the first pulse of the explosion. (B.L.M.)

33615 CALUTRON WITH MEANS FOR REDUCING LOW FREQUENCY RADIO FREQUENCY SIGNALS IN AN ION BEAM. Shipley, E. D.; Yonts, O. C.; Veach, A. M. (to U. S. Atomic Energy Commission). U. S. Patent 3,260,844. July 12, 1966.

The use of means in a calutron by which low frequency r-f oscillations in the ion beam are substantially negated, thus resulting in an ion beam in which beam-blowup is substantially reduced, and in a beam which is well focused with a marked improvement in beam quality is considered. This is accomplished by the use of two series of parallel, overlapping plates, each plate being connected to a grounded coil with one of each series of plates being bounded on each side of the ion beam from source to receiver, with a spacing from the ion beam up to one-half inch. With the use of the above plates, which do not contact each other, the beam is stable and well focused from 7×10^{-7} to 5×10^{-4} mm Hg. (AEC)

33616 HIGH CURRENT REVERSING SWITCH. Dexter, Warren L. (to U. S. Atomic Energy Commission). U. S. Patent 3,263,145. July 26, 1966.

A switch for controlling the direction of a large direct current from a source through a load is described. Four stationary switch contacts spaced apart by narrow gaps are disposed in quadrantial relation. Two sets of movable contacts provide electric connection across the gaps between selected pairs of adjacent stationary contacts. Switching is accomplished by withdrawing the movable contacts from the first two pairs of stationary contacts and advancing movable contacts toward the stationary contacts to provide connection between a differing two pairs of the stationary contacts. Due to the unique geometrical disposition of the switch contacts and the bridging elements, extreme compactness results. (AEC)

Radiation Detection

Refer also to abstracts 33103, 33128, 33275, 33563, 34660, 34665, 34830, 34885, and 34904.

33617 (BNL-940, pp 179-82) TROMBAY MULTIARM SPECTROMETER. Iyengar, P. K. (Atomic Energy Establishment, Trombay (India)).

The spectrometer described has a monochromator providing neutrons of readily variable energy and up to five analyzing spectrometers which examine the sample distributed in the range of scattering angles from +120 to -90°. The design follows that of a triple-axis spectrometer, and the motion of different arms and the incident energy are controlled by electromechanical automation. This instrument is mainly used for studying phonon energies in crystal lattices simultaneously at different points in reciprocal space. (J.F.P.)

33618 (CONF-660303-35) CORRELATING THE ENERGY CALIBRATION OF NEUTRON VELOCITY SPECTROMETERS. Wynchank, S. A. R. (Columbia Univ., New York). [1966]. Contract AT(30-1)-755. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Physical Society, Conference on Neutron Cross Section Technology, Washington, D. C.

A description is given of the factors which affect energy determinations in the measurement of cross sections by time-of-flight methods. The establishment of "Zero Time" and effects of detector size and response are considered. Possible improvements in timing at the Columbia University Nevis Synchrocyclotron, by the use of a spark gap for the proton beam deflection and a phase correlation between the accelerating r-f and the deflection pulse are outlined. The value of intercomparison of data obtained from different laboratories is stressed, with especial regard to consistent energy differences between them. (auth)

33619 (COO-1545-5) SPARK LOCATION ACCURACY WITH MAGNETOSTRICTIVE WIRE CHAMBER SYSTEM. Stevens, Alan J.; Franklin, Frederick F. (Ohio State Univ. Research Foundation, Columbus). May 23, 1966. Contract AT(11-1)-1545. 18p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A magnetostrictive wire chamber system being developed is described, together with the results of an initial calibration experiment. (auth)

33620 (EUR-2793.e) RESOLUTION, EFFICIENCY, AND BACKGROUND EFFECTS IN SEMICONDUCTOR SANDWICH FAST NEUTRON SPECTROMETERS. Rydin, R. A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 46p. Dep. mn.

Four separate areas related to semiconductor sandwich spectrometer response were analyzed, making extensive use of digital computer calculations. These were: (1) Characteristic resolution response function for monoenergetic neutrons. Response functions were calculated for various layer thicknesses of ^{6}LiF and gold at a number of different energies. Results compare favorably with existing experimental data. (2) Relative detection efficiency vs neutron energy. The relative detection efficiency, for detection of the reaction products in coincidence, was calculated for both ^{3}He and ^{6}Li spectrometers as a function of detector orientation angle. The effect is found to be significant, especially for the ^{3}He spectrometer. (3) Effects of non-gaussian detector response. Spectrum unfolding techniques are essentially not necessary for ^{6}Li spectrometers above 0.5 Mev, but it was found that care must be taken to correctly interpret the absolute detection efficiency of the detector. (4) True coincidence background response. The true coincidence background response, due to reactions occurring in the silicon of the diodes, was calculated for the case of an incident Pu-α-Be neutron spectrum. The background was found to be due primarily to the ground state (n,p) and (n,α) reactions. The results are in good agreement with available experimental data. (auth)

33621 (IS-T-87) AN IMPROVED TECHNIQUE FOR TRACK PROFILE MEASUREMENT IN NUCLEAR EMULSIONS. Hall, James Edison (Ames Lab., Iowa State Univ. of Science and Tech.). May 1966. Contract W-7405-eng-82. 55p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

Thesis.

A microdensitometer utilizing a signal averaging digital computer was developed to discriminate between the charges of particles producing short tracks in nuclear emulsions. It was possible to average and store 1800 photoelectric profile signals per minute. For each track the photoelectric profiles of ten track segments, each 5.0 microns long, were averaged and stored by the computer, yielding a mean profile curve. Results of measurements made on tracks produced by known particles of charges 1, 2, and 3 are presented. The normalized area of the profile curve was found to give the best charge separation. Measured photometric mean track width (MTW) values were corrected for the depth of the tracks in the emulsion. The charge groups were completely separated by measurement of 50 microns of each track, requiring less than 15 minutes per track. (auth)

33622 (JINR-P-2675) IDENTIFIKATSIYA ZARYAZHENNYKH CHASTITS PO PARAMETRY. (Identification of Charged Particles by Using the Z/β Parameter). Golovin, B. M.; Kulyukina, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 8p. Dep. mn.

The application of the automatic pattern recognition for particle identification by using the z/β parameter is simulated. The pattern recognition is done on the basis of the algorithm which requires less machine time and smaller memory if compared with the algorithm of potential functions used by the authors earlier. (auth)

33623 (MIT-2098-167) A HIGH-RESOLUTION MAGNETIC SPECTROMETER WITH LARGE SOLID ANGLE. Smith, D. L.; Enge, H. A. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics. Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Aug. 23, 1965. Contract AT(30-1)-2098. 6p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The broad-range magnetic spectrograph for nuclear reaction studies with high resolution and broad energy range but relatively small solid angle ($\Omega \leq 10^{-3}$ steradian) is described. A quadrupole lens is used to correct for Doppler broadening when the median plane is vertical (perpendicular to the reaction plane). The principle of operation is shown, and the resolving power is given. (J.F.P.)

33624 (MIT-2098-168) SPLIT-POLE MAGNETIC SPECTROGRAPH FOR PRECISION NUCLEAR SPECTROSCOPY. Spencer, James E.; Enge, Harald A. (Massachusetts Inst. of Tech., Cambridge). [Aug. 25, 1965]. Contract AT(30-1)-2098. 34p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A split-pole, broad-range magnetic spectrograph was designed that uses the fringing fields associated with four pole boundaries to obtain two-directional focusing over the full energy range of $E_{max}/E_{min} = 8$. The spectrograph is also approximately second-order focusing in the plane of dispersion (median plane) over this entire range. Different magnetic configurations (pole shapes) were simulated by computer and used in a program designed to trace rays of different initial conditions through the spectrograph. These computer experiments were then used to optimize the design and resulted in an instrument with a theoretical resolving power of $p/\Delta p > 1600$ for an acceptance solid angle $\Omega = 2 \times 10^{-3}$ sterad and $p/\Delta p > 800$ for $\Omega = 4 \times 10^{-3}$ sterad for the full energy range. The resolving power increases rapidly with further decreases in acceptance solid angle or with a decrease in the energy range E_{max}/E_{min}. (auth)

33625 (MLM-1326) AN ELEMENTARY GUIDE TO THE MEASUREMENT OF FAST NEUTRON FLUXES. Anderson, M. E. (Mound Lab., Miamisburg, Ohio). June 1, 1965. Contract AT-33-1-GEN-53. 23p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

An introduction to the basic physics and mathematics involved in the measurement of fast neutron fluxes is presented. It describes methods for detection of neutrons and the factors which must be taken into consideration when the measurements are being made. A glossary of some of the significant terms is also included. (auth)

33626 (N-65-32043) BASIC RESEARCH IN SEMICONDUCTOR DETECTOR-DOSIMETER CHARACTERISTICS, AS APPLIED TO THE PROBLEMS OF WHOLE-BODY

DOSIMETRY. Annual Progress Report. (Southern Methodist Univ., Dallas, Tex.). July 1965. 52p. (NASA-CR-64562). CFSTI $3.00 cy, $0.50 mn.

Various facets of experimental and theoretical research were reported, including fabrication of lithium drifted silicon semiconductor detectors; stopping power measurements; charge-pulse response of silicon detectors; detector lifetime behavior studies; linear and Monte Carlo stopping power calculations; calculation of effective Z, A, and I values; and depth dose distribution calculations. A method for extracting information from proton stopping experiments is described; in this experimental study, the objective is to assess values of parameters in the Bethe-Block formula that describe the average rate of energy lost by a charged particle along the path of migration in matter in interactions with atomic electrons. A computer program on the Monte Carlo proton transport is presented, and data sheets are included for a test problem in which the slowing down of protons in silicon from 187 to 147 Mev is studied. Abstracts of studies on related subjects are also included. (STAR)

33627 (N-66-10648) DEVELOPMENT OF DATA UNFOLDING TECHNIQUES FOR CONTOURED SEMICONDUCTOR NEUTRON SPECTROMETER. Final Report. Shannon, James A. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). July 1, 1965. Contract NAS8-11631. 73p. (NASA-CR-67629). CFSTI $3.00 cy, $0.75 mn.

Calibration of the charge-sensitive amplifier of the system was performed by calibrating a pulse generator against the 5.476 Mev α particles from an ^{241}Am source incident on a surface barrier type of solid state detector. The source and detector were virtually windowless and no correction for windows was made. The location of the charged particle bin boundaries at 1.34, 1.74, 2.14 Mev were in turn impressed on the pulse height analyzer of the system by adjusting the 10-turn helipot of the pulse generator. It was noted that from the specifications accompanying the charge sensitive amplifier this procedure was accurate to within 1.5%. The silicon detector was suitably biased and placed as close to the Pu-α-Be source as possible. The charge particle spectrum, $N(E_Q)$, was displayed on a pulse height analyzer and recorded automatically with suitable equipment. The result of a 90-minute exposure was shown. (STAR)

33628 (NAA-SR-Memo-11816) INTERLABORATORY COOPERATIVE STUDY ON NEUTRON FLUX SPECTRAL MEASUREMENTS, CALCULATIONS, AND DATA CORRELATION FOR REACTOR IRRADIATION AND PHYSICS STUDIES. First Status Report. McElroy, W. N.; Baurmash, L.; Bingham, C.; Franklin, F.; Kinzer, J. (Atomics International, Canoga Park, Calif.). Jan. 13, 1966. Contract AT-11-1-GEN-8. 21p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The plans for the initial phase of an interlaboratory cooperative study on neutron flux spectral measurements, calculations, and data correlation for reactor irradiation and physics studies are discussed. Emphasis is placed on the reactor irradiation studies. Significant progress was made in developing procedures for correlating the results of different neutron damage studies. These procedures are based on the ability to obtain a reliable description of the neutron flux spectrum in an unknown test environment. Advanced analytical and experimental methods are being developed and used to provide this description. It is the intent of this cooperative effort to test the reliability of these advanced methods for application to programs involving material irradiations at Hanford. The results of the study will have direct application to other reactor test facilities, and to reactor physics as well as material damage studies. (auth)

33629 (NAS-NS-3109) PROCESSING OF COUNTING DATA. Stevenson, P. C. (Lawrence Radiation Lab., Univ. of California, Livermore). Sept. 24, 1965. Contract W-7405-eng-48. 167p. Dep. mn. CFSTI $1.75 cy, $1.00 mn.

Nuclear Science Series of the National Academy of Sciences–National Research Council, Washington, D. C. Committee on Nuclear Science.

Solutions are presented to problems important to radiochemists who are involved with collection, reduction, and interpretation of data arising from measurements using counting equipment. Information is included on mathematical techniques, statistics of counting data, resolution of decay data, measurement of half-lives, dead time and coincidence considerations, and measurement of absolute counting efficiency. (J.R.D.)

33630 (ORNL-3888) EFFICIENCY OF ORGANIC SCINTILLATORS FOR FAST NEUTRONS. Schuttler, R. J. (Oak Ridge National Lab., Tenn.). July 1966. Contract W-7405-eng-26. 61p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Organic scintillator detection efficiencies are estimated for incident neutrons above 12 Mev, in which region nonelastic reactions in the carbon of the detector become significant. The efficiency is given in a "first effective collision" approximation, later corrected for second-collision effects, as a function of a detector threshold on the fast component of the light from the phosphor. The analysis includes consideration of nonlinear light production of both fast- and slow-light components, pulse-shape discrimination against gamma rays, the detector's pulse-height resolution, and edge effects. Effective carbon cross sections are approximated by combining a Monte Carlo intranuclear cascade and evaporation contribution with the experimental $^{12}C(n,\alpha)^{9}Be$ cross section. Pulse heights are summed from the series of particles emitted in the reaction of a given incident neutron with a carbon nucleus, including pulses from secondary neutron interactions. For 14.5-Mev incident neutrons onto NE-213 detectors 2.61 and 6.1 cm thick, the method yields efficiencies of 9.7 and 21.7% for a fast-light threshold equivalent to pulses from 200-kev electrons, if no pulse-shape discrimination against gamma rays is employed. (auth)

33631 (ORNL-TM-1517) MULTIPLE COULOMB SCATTERING INTO A DETECTOR IN CHARGED PARTICLE COINCIDENCE MEASUREMENTS BETWEEN REACTION PRODUCTS. Peelle, R. W. (Oak Ridge National Lab., Tenn.). June 16, 1966. Contract W-7405-eng-26. 17p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Assuming that the particles which strike a circular detector are displaced by multiple Coulomb scattering according to a bivariate normal density function, the fraction of the detected particles which if undeflected would have struck the detector plane outside a circle of specified larger radius is described. The problem is solved exactly by numerical quadrature, and approximately in the case that the r.m.s. displacement caused by the scattering is much less than the detector radius. The latter form may be employed for noncircular detectors. Numerical results are compared for a wide range of cases. The results of this calculation are applicable to experiments in which the output particles from a binary reaction are observed in coincidence. Multiple scattering in the target or in an interposed material causes some of the charged particles striking the first detector to have conjugate particles outside the kinematically prescribed cone which maps the first detector in the plane of the second, and so the second detector must be larger than would be estimated ignoring multiple scattering. This correction is important to scintillator neutron efficiency measurements by the D(T,^{3}He)n reaction, and should apply to other experiments where coincidence detection is used to define the reaction being studied. The results are tentative in that the normal density function is not a very accurate description of the multiple scattering. (auth)

33632 (SGAE-PH-38/1966) INFLUENCE OF PHOTOELECTRON STATISTICS ON TIME-CORRELATIONS IN FAST COINCIDENCE MEASUREMENTS. Halling, H.; Mayerhofer, S.; Nablelek, H.; Ujlaki, E. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Elektronikinstitut. Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). 1966. 20p. Dep. mn.

Prompt curves with an exponential slope are observed in

lifetime measurements of low energy γ transitions by means of a NaI(Tl)-scintillator. In this case the statistics of electrons emitted from the photocathode determines the resulting time-correlations. These time-correlation functions are calculated on the basis of a simple statistical model. The agreement between the experimental curves and the calculations is demonstrated and a disagreement in the observed initial photoelectron rate with other experimental data is discussed. (auth)

33633 (UCRL-14633) AN INSTRUMENT TO DEFINE RADIOACTIVE CLOUDS AND ITS APPLICATION IN MONITORING UNDERGROUND NUCLEAR TESTS AT NEVADA TEST SITE. King, W. C. (Lawrence Radiation Lab., Univ. of California, Livermore). June 20, 1966. Contract W-7405-eng-48. 27p. (CONF-660621-3). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From Health Physics Society, 11th Annual Meeting, Houston, Tex.

The instrument, named Skyscanner, will give a profile of activity vs cloud height. If two skyscanners are in use, triangulation of data can be used to locate cloud position accurately. Analysis of errors in the processing and assumptions of Skyscanner data indicate that the computed results may be within a factor of 2 of true release values. Present systems may only be as good as a factor of 4. (J.R.D.)

33634 (UCRL-16542) RECENT DEVELOPMENTS IN SPARK CHAMBERS. Wenzel, W. A. (Lawrence Radiation Lab., Univ. of California, Berkeley). Feb. 28, 1966. Contract W-7405-eng-48. 17p. (CONF-660304-21). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From Institute of Electrical and Electronics Engineers, Scintillation and Semiconductor Counter Symposium, Washington, D. C.

The parallel developments of a variety of spark-chamber schemes have produced many workable systems with success in experimental applications. Major efforts have developed several methods for direct electrical readout of spark-chamber data. These include the use of magnetic cores for direct digitizing of information from wire spark chambers, as well as the use of Vidicon cameras to observe sparks, and of current division and acoustic transit time in analogue devices to measure spark position. For such systems the on-line use of computers, and (or) the construction of significant electrical interfacing circuitry, are important considerations in efforts to maximize the event rate. Conventional spark-chamber systems using film to record data have benefited from the continued development of automatic off-line scanning and measuring systems. There are also many experiments that will use the unique capabilities of wide-gap spark and streamer chambers. (auth)

33635 PORTABLE MONITOR FOR THE ESTIMATION OF TRITIUM IN AQUEOUS SAMPLES. Iyengar, T. S.; Sadarangani, S. H.; Soman, S. D.; Somasundaram, S.; Vaze, P. K. (Atomic Energy Establishment, Trombay, India). Amer. Ind. Hyg. Ass. J., 27: 288-92(May-June 1966).

A portable instrument utilizing an ionization chamber for the estimation of tritium in aqueous samples is described. The ionization chamber is filled with acetylene from the test specimen by simple displacement of air. The ionization current resulting from the beta disintegrations of tritium is measured by a sensitive electrometer. The instrument, which is highly useful in field work for checking spot samples of irradiated heavy water, cold-strip air samples, etc., has a fairly linear response over a wide range of specific activity values. The lowest limit of estimation is 0.16 mC/liter, corresponding to a current of 1×10^{-13} ampere. (auth)

33636 MEASUREMENTS WITH SOME RESONANCE DETECTORS. Koehler, W.; Knopf, K. (Technische Hochschule, Munich). Atomkernenergie, 11: 321-3(July-Aug. 1966). (In German).

The differential flux density was measured in the region from 5 ev to 0.4 kev by simultaneous activation of (n,γ)-detectors. Assuming a 1/E-distribution, one gets a mean deviation of ±14% from the measurements with ^{197}Au, ^{152}Sm, ^{186}W, ^{139}La, and ^{55}Mn. The most significant deviations were found for ^{152}Sm and ^{186}W, two reactions with less well known resonance integrals. The values measured for ^{197}Au, ^{55}Mn, and ^{139}La agree within the limits of error, which are mainly those of the errors in resonance activation integrals (max 12%). (auth)

33637 SIMPLE METHOD FOR AN EXACT EFFICIENCY DETERMINATION IN LIQUID SCINTILLATION COUNTING OF LOW-ENERGY BETA EMITTERS. Schwerdtel, E. (Frieseke and Hoepfner GmbH, Erlangen, Ger.). Atomkernenergie, 11: 324-5(July-Aug. 1966). (In German).

A method is described for determining accurately the counting efficiency in the measurement of tritium and other low-energy beta emitters in liquid scintillators down to very low values by means of a coincidence circuit of three photomultipliers. (auth)

33638 TEMPERATURE REGULATOR FOR SCINTILLATION CRYSTALS. Csanky, Lajos; Novak, Dezso. ATOMKI (Atommag Kut. Intez.) Kozlem., Mellek., 8: 23-6 (1966). (In Hungarian).

An apparatus was built for controlling the temperature of scintillation crystals in the range from 130 to 370°K. At temperatures above room temperature, the error in the regulation is ±0.1°. For lower temperatures, the error increases: at 200° it is ±0.8°, and at 150°, ±2°. (auth)

33639 PULSE HEIGHT DISTRIBUTIONS FROM PROPORTIONAL COUNTERS. Campbell, J. L.; Ledingham, K. W. D. (Univ., Glasgow). Brit. J. Appl. Phys., 17: 769-74(June 1966).

The pulse height distributions from the characteristic K x rays of carbon, fluorine, magnesium, and aluminum absorbed in a proportional counter were investigated and found to approximate to a type of Poisson distribution, the relative standard deviation having the value $0.169/E^{\frac{1}{2}}$ where E is the x-ray energy in kev. The spectrum of single photoelectrons of essentially zero energy was examined and its shape found to vary with counter voltage at high gas multiplication where the counter is no longer proportional. (auth)

33640 SOME FACTORS AFFECTING SPATIAL UNIFORMITY OF RESPONSE IN WHOLE-BODY COUNTERS. Oliver, R.; Warner, G. T. (Churchill Hospital, Oxford. Radcliffe Infirmary, Oxford). Brit. J. Radiol., 39: 554-6 (July 1966).

Improvements in the spatial uniformity of response in whole-body counters was obtained by: use of two opposed detectors; recording the total traverse count as the activity passed through the limited counting region of two collimated detectors; and the acceptance of pulses in a wide energy band, rather than using the photo-peak counting technique. (P.C.H.)

33641 EFFECT OF OXYGEN ON THE COMPUTING ABILITIES OF PROPORTIONAL COUNTERS FILLED WITH MIXTURES OF CARBON DIOXIDE AND METHANE. Starcuk, Zenon; Cupak, Miloslav (Vyzkumny Ustav Makromolekularni Chemie, Brno). Cesk. Cas. Fys., 16: 333-7(1966). (In Czech).

The effect of oxygen on the computing abilities of proportional counters filled with mixtures of carbon dioxide and methane is investigated. Based on the dependence obtained, the requirements on the degree of elimination of oxygen both from carbon dioxide and methane are specified. It was found that even for comparatively low relative contents of methane in the filling the probability that negative oxygen ions might be formed in the counters is appreciably smaller than in counters filled only with CO_2. (auth)

33642 NON-IRON ASYMMETRIC TWO-LENS BETA SPECTROMETER WITH CORRECTIVE COILS. Bonchev, T.; Ormandjiev, S.; Zlatareva, A.; Mitrikov, M.; Todorov, P.; Manoushev, B. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 18: 1099-1102(1965).

The characteristics of the two-lense non-iron asymmetric beta spectrometer were improved by introducing several corrective coils. The performance of this spectrometer showing the effects of the corrective coils is given. (J.F.P.)

33643 NEW MANNER OF APPLYING E(dE/dx) METHOD OF DISCRIMINATION OF PARTICLES. Renaud, Jean; Depraz, Jean (Institut de Physique Nucleaire, Lyon). Compt. Rend., Ser. B, 262: 1403-4(May 23, 1966). (In French).

The expression $E^{0.8}\Delta E$ almost independent of the initial energy of the particles for a large range of energy and of thicknesses of silicon from 10 to 50 μ seems well adapted to their discrimination. (tr-auth)

33644 RADIOLOGICAL SURVEY METERS. Ello, J. G. (Argonne National Lab., Ill.). Electron. World, 75: 44-7(Jan. 1966).

Design, construction, operating characteristics, and use of various type of radiation detectors are outlined, and the operation and maintenance of civil defense fallout meters using ionization chambers and Geiger-Mueller tubes are discussed. Methods used by technical personnel in the nuclear instruments field are also dealt with. The Civil Defense Model V-715 meter is shown. It is used primarily for measuring total dose radiation rates up to 500 R/hr. The circuits, powered by two conventional type D flashlight batteries, are partially transistorized to minimize current drain. The circuit diagram of the CD V-715 survey meter is also shown and the two internal circuits should be considered: the electrometer circuit and the indicating meter circuit. The Civil Defense Model V-700 survey meter, which is shown, is primarily used for detecting radioactive contamination up to 50 mR/hr. The survey meter employs a β-γ sensitive Geiger-Mueller tube as its detector. A single control selector switch operates the survey meter, and selects any one of the three ranges. Calibration and maintenance of the meters are discussed. The detector insulators, electrometer tube, high-megohm range resistors, switch sections, and high-voltage insulator are all parts of the high-resistance input circuit. (BBB)

33645 THE BREMSSTRAHLUNG DOSE FROM ^{147}Pm ON Zn, CdS(Cu). Bizzarri, B.; Serra, M. (Univ., Rome). Energ. Nucl. (Milan), 13: 323-7(1966).

Measurements of radiation dose were performed in connection with experiments on the radio-luminescence produced in Zn, CdS(Cu) by β rays from ^{147}Pm. Such measurements supply all the data necessary to calculate the radiation dose produced by large radio-luminescent sources. (auth)

33646 TENTH SCINTILLATION AND SEMICONDUCTOR COUNTER SYMPOSIUM, WASHINGTON, D. C., MARCH 2-4, 1966. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 1-601(June 1966). (CONF-660304).

Separate abstracts were prepared for 60 of the 74 papers included. The remaining papers can be found under CONF-660304 in the report number index. (G.O.Y.)

For abstracts of individual papers see: 33275, 33647–33702, 33735, 33766, and 34830.

33647 RADIATION DETECTORS IN HIGH-ENERGY PHYSICS. Piroue, Pierre A. (Princeton Univ., N. J.). Contract Nonr-1858(06). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 1-8(June 1966).

The various types of spark chambers are briefly reviewed, including narrow-gap, wide-gap and filmless chambers. Applications of scintillation detectors are discussed, together with remarks on light pipes, localization of particles by time-of-flight, use of multiparameter pulse-height analysis, hodoscopes, and on-line computers. The use of Cherenkov counters is summarized. Several new types of detectors are considered which may be suitable for identification of particles of very high energy. (auth)

33648 DETECTORS IN BIOLOGY AND MEDICINE. Dunham, Charles L. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 9-17(June 1966).

Detector applications are discussed for three fundamental areas of Biology and Medicine: Radiobiology, Photobiology, and Nuclear Medicine. Examples of biomedical work in progress are given which have been made possible by the development of adequate detectors. The biological and medical significance of the work is discussed and some needed detector advances are pointed out. (auth)

33649 SOME RECENT APPLICATIONS OF SCINTILLATION AND SOLID-STATE COUNTERS IN CHEMISTRY. Sayre, Edward V. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 18-20(June 1966).

The use of scintillation and proportional counters, amplitude selection, coincidence and anti-coincidence techniques, and the Mossbauer effect are discussed for various applications from x-ray crystallography to the detection of neutrino induced reactions. The anisotropic behavior or channelling in silicon detectors is also discussed. (auth)

33650 APPLICATIONS OF DETECTORS IN LOW-ENERGY NUCLEAR PHYSICS. Donovan, P. F. (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 21-33(June 1966).

Some recent applications of detectors in low-energy nuclear physics are discussed with emphasis on semiconductor detectors. The limitations and possibilities of detectors in areas of particular importance to nuclear physics are also considered. (G.O.Y.)

33651 RECENT DEVELOPMENTS IN SPARK CHAMBERS. Wenzel, W. A. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 34-45(June 1966).

The development of wide-gap spark-mode chambers, wide-gap streamer-mode chambers, and microwave discharge chambers is briefly reviewed. Systems for automatic film scanning and measurement are also considered, as are filmless spark-chamber techniques and spark-chamber trigger logic. 50 references. (D.C.W.)

33652 HYBRID PHOTOMULTIPLIER TUBES USING INTERNAL SOLID-STATE ELEMENTS. Wolfgang, L. G. (ITT Industrial Labs., Fort Wayne, Ind.); Abraham, J. M.; Inskeep, C. N. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 46-53(June 1966).

The characteristics and advantages of photomultiplier tubes that use silicon diodes and transistors as multiplying elements are discussed. (G.O.Y.)

33653 PHOTOCATHODES USED IN PHOTOMULTIPLIER TUBES FOR SCINTILLATION COUNTERS: CHARACTERISTICS AND EFFECT ON PERFORMANCE. Stanley, V. A. (EMI Electronics Ltd., Middlesex, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 63-71(June 1966).

A variation of the Sb–Cs cathode with a quantum efficiency of up to 30% was developed. The characteristics of this cathode are compared with those of the Cs–K bialkali cathode, the trialkali cathode, and other variants of the Sb–Cs cathode. The parameters dealt with are quantum efficiency, spectral response, dark current at various temperatures, and the resolution for gamma rays of both high and low energy. (auth)

33654 MULTIPLE REFLECTION EFFECTS OBSERVED FOR S-1, S-11, AND S-20 PHOTOCATHODES. Gumnick, J. L.; Hollish, C. D. (ITT Industrial Labs., Fort Wayne, Ind.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 72-6(June 1966).

The influence of light trapping on the performance of photocathodes is described using a simple optical model. The model is based on the assumption that light trapping occurs as a result of total internal reflection in the face-plate-photocathode structure. The analysis based on the model predicts that successive light-photocathode interactions are related through a geometric progression, and the ratios of light intensities and photoelectric yields associated with successive light-photocathode interactions are equal to the common ratio of the progression. Experiments on S-1, S-11, and S-20 type photocathodes tend to confirm three predictions based on the analysis: that the logarithm of the photocurrent for a specific interac-

tion is a linear function of the number denoting the interaction; the successive photocurrents and light intensities have the same ratio denoted K, and that the ratio of the total photocurrent to that of the first interaction approaches $1(1-K)^{-1}$. (auth)

33655 PERFORMANCE OF A PHOTOMULTIPLIER WITH A POROUS TRANSMISSION DYNODE. Smith, H. M.; Ruedy, J. E.; Morton, G. A. (Radio Corp. of America, Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 77-80 (June 1966).

A photomultiplier incorporating a porous emission KCl layer as the first dynode was built and tested. The results showed that the statistics of a porous layer dynode are worse than those of conventional secondary emitters. (G.O.Y.)

33656 SECONDARY ELECTRON MULTIPLICATION IN IMAGE INTENSIFIER DYNODE STRUCTURES. Reynolds, Geo. T. (Princeton, Univ., N. J.). Contract AT(30-1)-3406. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 81-7 (June 1966).

The distribution in the number of photons in the light pulses from the phosphor of a five dynode transmission secondary electron image intensifier (TSEM) was measured for single photoelectrons emitted from the cathode. This distribution reflects the distribution in the secondary electron multiplication in the dynode structure. The distribution is monotonically decreasing, but deviates significantly from a simple exponential. The noise distribution was also studied, and several different components were distinguished. The effects on these components of cooling the cathode were investigated. The results from the TSEM are compared with corresponding results obtained using three-stage cascaded-type image intensifiers. (auth)

33657 MECHANISM OF CHANNEL ELECTRON MULTIPLICATION. Adams, J.; Manley, B. W. (Mullard Research Labs., Surrey, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 88-99 (June 1966).

The important parameters observed in a channelled electron multiplication are related to the physical processes involved. Ionic feedback and the effect of channel geometry are discussed. Saturation effects occurring in straight channels and in curved channels are described, and the different pulse-height distributions are contrasted. (auth)

33658 CONTINUOUS CHANNEL ELECTRON MULTIPLIER OPERATED IN THE PULSE SATURATED MODE. Schmidt, K. C.; Hendee, C. F. (Bendix Corp., Southfield, Mich.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 100-11 (June 1966).

Peaked pulse-height distributions are obtained from curved channel electron multipliers at high gain levels. They are caused by a gain saturating mechanism which limits the instantaneous output current from the multiplier. Various limiting mechanisms are considered. Experimental and theoretical evidence strongly supports the hypothesis that space-charge limiting is the major cause of gain saturation. (auth)

33659 PERFORMANCE OF GRID-CONTROLLED PHOTOMULTIPLIERS IN THE NANOSECOND REGION. Goerlich, P.; Pohl, H.-J.; Mukhin, S. V.; Semenyushkin, I. N. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 112-18 (June 1966).

The performance of a fast photomultiplier with two control grids was investigated experimentally and theoretically. (D.C.W.)

33660 MEASUREMENT OF RESOLVING TIMES WITH THE FAST RCA C-70045 PHOTOMULTIPLIERS. Miehe, J. A.; Ostertag, E.; Coche, A. (Centre de Recherches Nucleaires, Strasbourg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 127-31 (June 1966).

Some RCA C-70045 photomultipliers were tested in a delayed coincidence apparatus. Resolving time measurements were performed by illuminating the photocathode of the multiplier with constant-height light pulses. Prompt resolution curves were then measured using two photomultipliers in conjunction with two plastic scintillators. A time resolution of 1.85×10^{-10} sec was obtained with ^{60}Co. (G.O.Y.)

33661 LINEWIDTHS IN NaI(Tl) SCINTILLATION COUNTERS FOR LOW-ENERGY GAMMA RAYS. Narayan, G. H.; Prescott, J. R. (Univ. of Alberta, Calgary, Can.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 132-7 (June 1966).

The line-width for a number of NaI(Tl) scintillation counters for low energy gamma-rays was examined in detail down to an energy of 6 kev. Below 100 kev, the photomultiplier accounts for about half the relative variance. For energies in the range 30–40 kev there is a curious anomaly in the linewidth, interpreted as being associated with the K-edge of iodine at 33.2 kev. The surface preparation of the crystal has an effect on the line-width which differs markedly from region to region over the whole energy range below about 100 kev. (auth)

33662 IMPROVED TIMING WITH NaI(Tl). Lynch, Frank J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 140-7 (June 1966).

It was found that by timing on the earliest component of the anode current pulse of the photomultiplier, the time resolution obtained with NaI(Tl) at 300°K can be made somewhat superior to that reported for NaI at 77°K. The observed resolution requires at least 8.7 photoelectrons/kev. (D.C.W.)

33663 DECAY TIMES OF COMMERCIAL ORGANIC SCINTILLATORS. Yates, E. C.; Crandall, D. G. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 153-8 (June 1966). (EGG-1183-2084).

Response curves showing both short and long decay components are presented for fifteen commercially available scintillators. Scintillator time-response functions for detection of 1.114-Mev gamma radiation (^{65}Zn) were measured over a range of three decades by employing a delayed coincidence technique. The region of the decay curve between 70 and 7% of the peak value is found to be very nearly exponential for most scintillators. The decay time for this region was determined for each scintillator to an accuracy of ±0.1 nanosecond. (auth)

33664 SCINTILLATION CHARACTERISTICS OF ^{241}Am DOPED THALLIUM ACTIVATED SODIUM IODIDE. Menefee, J.; Cho, Y. (Harshaw Chemical Co., Cleveland). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 159-61 (June 1966).

The scintillation response of NaI(Tl) crystals to an alpha emitter, ^{241}Am, grown into the crystal lattice was investigated. The data obtained include alpha peak resolution, the gamma equivalent energy of the alpha peak, and the variation of relative pulse height and gamma equivalent energy with temperature from –50 to +150°C, as well as the specific activity levels attained. (G.O.Y.)

33665 STUDIES OF THE RESPONSE SPEED OF SILICON-SURFACE BARRIER DETECTORS, WHEN IRRADIATED WITH DIFFERENT PARTICLES. Meyer, H. (European Atomic Energy Community, Geel, Belg.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 180-8 (June 1966).

The rise time of surface-barrier detectors for α particles, fission fragments, and conversion electrons was measured with and without over-voltage and was compared with calculations. The detectors were produced from n-type silicon with resistivities in the range 250 Ωcm to 9000 Ωcm. The contribution of the plasma time due to the erosion of the ionization tracks with their high carrier density by the field was studied in detail. (G.O.Y.)

33666 NOISE ANALYSIS FOR A SILICON PARTICLE DETECTOR WITH INTERNAL MULTIPLICATION. Haitz, Roland H. (Texas Instruments, Inc., Dallas); Smits, F. M.

IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 198-207 (June 1966).

The significance of two noise sources in a Si particle detector is evaluated. It is found that in general internal carrier multiplication will improve the energy resolution only for the detection of low-energy particles and for moderate values of the multiplication factor. The findings are illustrated by detailed calculations for a silicon junction with a breakdown voltage of 30 v and a corresponding space-charge layer thickness of 1.3 microns which is appropriate for low-energy particle detection. (G.O.Y.)

33667 THE CHECKER BOARD COUNTER: A SEMICONDUCTOR dE/dx DETECTOR WITH POSITION INDICATION. Hofker, W. K. (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands); Oosthoek, D. P.; Hoeberechts, A. M. E. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 208-13 (June 1966).

A dE/dx detector with subdivided electrodes is described. The detector provides information on the position of the incident particles. The electronic read-out system of the detector is also described. (D.C.W.)

33668 VACUUM-ENCAPSULATED LITHIUM-DRIFT DETECTOR TELESCOPE. Hayashi, I.; Kern, H. E.; Rodgers, J. W.; Wheatley, G. H. (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 215-20 (June 1966).

The design and fabrication of a windowless vacuum-encapsulated detector telescope for space experiments are discussed. (D.C.W.)

33669 LOW-BACKGROUND SEMICONDUCTOR COUNTER TELESCOPE FOR NEUTRON REACTION STUDIES. Lalovic, B.; Ajdacic, V.; Pai, H. L.; Petrovic, B. (Univ. of Toronto). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 221-4 (June 1966).

A telescope system is described in which coincidence or anticoincidence of associated alpha particle pulses from the $^3H(d,n)^4He$ reaction with pulses produced in the counters is required in order to reduce the background in investigations of 14 Mev neutron induced reactions. By using current pulse transformers with surface-barrier semiconductor counters and fast electronics, a coincidence resolving time between neutron induced pulses in the counters and associated alpha particle pulses of 1.6 ns is obtained, and the background is reduced by an order of magnitude. The same method may be used for studies using lithium-drifted germanium counters, both with 14 Mev neutrons and neutrons produced in the $^2H(d,n)^3He$ reaction. (auth)

33670 RESOLUTION LIMITATION OF SOLID-STATE RADIATION DETECTORS FOR HEAVY PARTICLES. Siffert, P. (Centre de Recherches Nucleaires, Strasbourg); Coche, A.; Hibou, F. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 225-30 (June 1966).

The resolutions of semiconductor detectors were measured for protons, deuterons, α particles, and $^4He^+$ ions at different energies between 20 kev and 5.5 Mev. Limits of the Fano factor were obtained and the contribution of nuclear collisions to the half-maximum width of the α-particle peaks were evaluated. The differences between electron-hole pair creation energies for the different particles were also measured. (G.O.Y.)

33671 EFFECTIVE CHARGE CARRIER LIFETIME IN SILICON p-i-n JUNCTION DETECTORS. Coleman, J. A.; Swartzendruber, L. J. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 240-4 (June 1966).

A technique for measuring the effective lifetime of carriers in a p-i-n junction detector is outlined, and the results of measurements of effective electron lifetimes in silicon p-i-n junction detectors are presented. (D.C.W.)

33672 DRIFT RATE AND PRECIPITATION OF LITHIUM IN GERMANIUM. Henck, R.; Stab, L.; da Silva, G. Lopes; Coche, A.; Siffert, P. (Centre de Recherches Nucleaires, Strasbourg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 245-51 (June 1966).

The effects of resistivity, lifetime of minority carriers, nature of acceptors, and Cu diffusion on the drift rate were investigated. The concentration of Li^+ ions and the rate of Li precipitation were measured using thermoelectric probes. The effect of Li precipitation on the drift rate was also considered. (D.C.W.)

33673 OBSERVATIONS ON THE ENERGY RESOLUTION OF GERMANIUM DETECTORS FOR 0.1 TO 10-Mev GAMMA RAYS. Mann, H. M.; Bilger, H. R.; Sherman, I. S. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 252-64 (June 1966).

The ratio of variance to yield was studied for γ rays at energies up to 10.08 Mev in lithium-drifted germanium detectors. With detectors of thickness up to 14 mm, this ratio was found to be as low as 0.13 ± 0.02 at 122 and 356 kev. At energies between 1 and 10 Mev, the ratio was found to be 0.16 ± 0.01, corresponding to a detector contribution of 4.8 ± 0.1 kev (FWHM) at 10 Mev. An investigation of the dependence of the ratio of variance to yield on electric field intensity resulted in acceptance of $F = 0.13 \pm 0.02$ as the best experimental estimate of the Fano factor, and $F = 0.16$ is interpreted as an upper limit for γ rays at energies between 1 and 10 Mev. (auth)

33674 PULSE-SHAPE DISTRIBUTIONS FROM GAMMA RAYS IN LITHIUM-DRIFTED GERMANIUM DETECTORS. Strauss, M. G.; Larsen, R. N.; Sifter, L. L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 265-73 (June 1966).

Pulse-shape distributions resulting from the interaction of gamma rays in germanium detectors were studied as a function of field intensity, gamma energy, and detector width. It was observed that at 2300 v/cm, the initial rate of charge collection approached 10 nsec/mm. Due to a slow component, the total charge collection was about 30% longer. At 1000 v/cm the collection time was somewhat longer, and at 250 v/cm it was considerably longer. These observations appeared to be independent to gamma energy in the range of 0.6 to 3 Mev and at detector widths of 3 to 11 mm. Events interacting near the center of the detector result in fast-rising pulses and those interacting near one of the electrodes have a risetime which is approximately twice as long, thus giving rise to a distribution of pulse shapes. (auth)

33675 DETECTION OF HIGH-ENERGY PROTONS BY THIN-WINDOW LITHIUM-DRIFTED GERMANIUM COUNTERS. Pehl, R. H.; Landis, D. A.; Goulding, F. S. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 274-8 (June 1966). (UCRL-16722).

The results of an investigation of the response of thin-window Li-drifted Ge detectors to 29- and 40-Mev protons are presented. A comparison with the response of a 0.5-cm-thick, high-voltage Li-drifted Si detector is included. (D.C.W.)

33676 TOTAL-ABSORPTION DETECTOR FOR 60-Mev PROTONS USING LITHIUM-DRIFTED GERMANIUM. Bertrand, F. E.; Peelle, R. W.; Love, T. A.; Fox, R. J.; Hill, N. W.; Todd, H. A. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 279-84 (June 1966). (ORNL-TM-1462).

A Li-drifted Ge diode that was developed for the detection of 60-Mev protons by total absorption is described. The results of some tests of the detector are summarized. (D.C.W.)

33677 IMPROVEMENTS IN LARGE-VOLUME COAXIAL GERMANIUM SPECTROMETERS. Malm, H. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 285-96 (June 1966).

Charge collection time distributions from several Ge(Li) spectrometers were measured by gating the timesorter only when the full energy of 511-kev gamma pulses were

registered in both the NaI(Tl) crystal and the Ge(Li) diode. The leading edge time distributions for a coaxial diode were compared to those of a planar diode. The planar diode has a symmetrical time distribution, while the coaxial diode has a wider and asymmetric time distribution. The fabrication, efficiency, and performance of these diodes as spectrometers are also discussed. (G.O.Y.)

33678 USE OF Ge(Li) DETECTORS IN γ-γ COINCIDENCE EXPERIMENTS. Ewan, G. T.; Graham, R. L.; MacKenzie, I. K. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 297-305(June 1966).

Large-volume Ge(Li) detectors were used in a γ-γ coincidence arrangement employing two Ge(Li) detectors. The results of studies of the timing properties of planar and coaxial diodes and of the time resolution curves that can be obtained are presented. For two cylindrical coaxial diodes, the full-width at half-maximum of the time resolution curve was 14 nsec for 511-kev γ rays. The application of the detectors in γ-γ coincidence experiments is also described. The coincidence counting rates are limited by the total singles counting rates that can be tolerated without excessive loss of energy resolution. Results are shown illustrating the application of a Ge(Li)–Ge(Li) coincidence arrangement to a complex γ spectrum and the ability of this technique to reveal new information on γ-γ cascades. (auth)

33679 THEORETICAL AND EXPERIMENTAL RESULTS ON THE RESOLVING TIME OF p–i–n DETECTORS IN γ-γ COINCIDENCE EXPERIMENTS. Pigneret, J.; Samueli, J. J.; Sarazin, A. (Institut de Physique Nucleaire, Lyon). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 306-14(June 1966).

A calculation of the resolving time that can be obtained by the delayed-coincidence method with a p–i–n detector is presented. The results show that submillimicrosecond time resolution can be obtained with a 2-mm-thick detector. Experimental results lead to 1.1 ns (FWHM) with a ^{60}Co source and 2.8 ns with a ^{22}Na source. The broadening of the prompt spectrum is explained in terms of the electronic system noise. (auth)

33680 CHARACTERISTICS OF SOME LARGE, COAXIAL LITHIUM-DRIFT SEMICONDUCTOR GAMMA-RAY SPECTROMETERS. Tavendale, A. J. (Australian Atomic Energy Commission Research Establishment, Sydney). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 315-27(June 1966).

Large-volume, Li-drifted Ge and Si diodes were fabricated using the coaxial configuration, and their characteristics as diodes and gamma spectrometers were investigated. (D.C.W.)

33681 PREPARATION OF LARGE-VOLUME PLANAR GERMANIUM DETECTORS AND RESULTS OF THEIR USE IN NUCLEAR PHYSICS EXPERIMENTS. Mann, H. M.; Janarek, F. J.; Helenberg, H. W. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 336-50(June 1966).

Improved performance of germanium detectors, prepared by use of lithium-drift techniques, was obtained by means of measurements of diode properties and surface resistivity during preparation. A compensated thickness of 16 mm was obtained for several detectors in a single drift operation. For these and other detectors the provision of a negligible (<10μ) dead layer on one side allowed the detector to be useful from 10 kev to 10 Mev. An electric field intensity of 50 to 175 v/mm was sufficient to give satisfactory energy resolution and full counting efficiency for detectors of thickness up to 16 mm. The preparation of 2–3 mm thick detectors by use of a dual-drift procedure, wherein two adjacent diode structures are caused to merge, is described. The joint use of coaxial and planar techniques, and their relative advantages, are discussed. It is concluded that the preparation of germanium detectors of area 25 cm^2 and thickness 1.5–3.0 cm is feasible with present techniques, but limited by the quality of the crystals utilized. The results of application of these detectors to muonic x-ray studies, neutron-capture gamma-ray experiments, charged-particle induced reactions involving gamma rays, and isotopic analysis of materials such as uranium are presented. An advantage of a reduction in sensitive volume for some measurements at energies in the range 5–10 Mev is shown. (auth)

33682 ENCAPSULATED GERMANIUM γ-RAY SPECTROMETERS. PERFORMANCE CHARACTERISTICS AND OPERATIONAL EXPERIENCE. Webb, P. P. (RCA Victor Co. Ltd., Montreal); Green, R. M.; Fowler, I. L.; Malm, H. L. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 351-8(June 1966). (AECL-2573).

The performance characteristics of various hermetically sealed Ge(Li) diodes for gamma spectrometry were investigated. Encapsulation details for large-volume planar and coaxially drifted diodes are discussed. The results of measurements of the intrinsic full-energy peak efficiency, the voltage ratings, and the resolutions of various diodes are presented. (G.O.Y.)

33683 TEMPERATURE DEPENDENCE OF THE RESPONSE OF LITHIUM-DRIFTED GERMANIUM DETECTORS TO GAMMA RAYS. El-Shishini, M. M.; Zobel, W. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 359-62(June 1966).

The resolution and efficiency of two lithium-drifted germanium detectors, approximately 20 mm in diameter and 3 mm thick, were investigated as a function of detector temperature in the range from 85 to 160°K. Gamma energies ranged from ^{203}Hg (279 kev) to ^{60}Co (1333 kev). It was found that, contrary to previous results, the resolution of the detectors had a pronounced peak at about 105°K. The origin of this peak is, at present, unknown, but is not due to changes in diode capacitance or leakage current. (G.O.Y.)

33684 LITHIUM DRIFT RATES AND OXYGEN CONTAMINATION IN GERMANIUM. Fox, R. J. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 367-9(June 1966).

The kinetics of Li precipitation were investigated in 24 samples cut from 13 different Ge crystals covering a wide range of drift rates. These samples were cut from both zone-leveled and pulled crystals. The results indicate the presence of O in all crystals of non-driftable Ge. The same features, which were previously found to characterize Li precipitation in oxygen-doped Ge crystals, were invariably seen in Ge that drifted slowly. (G.O.Y.)

33685 CORRELATION BETWEEN LITHIUM-DRIFT MOBILITY AND MINORITY-CARRIER DRIFT MOBILITY IN GERMANIUM. Armantrout, Guy A. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 370-2(June 1966). (UCRL-14791).

The minority-carrier drift mobility of driftable and nondriftable Ge was measured in an effort to determine the presence of an impurity which reduced the Li drift mobility but did not affect the resistivity and lifetime of some of the material used to make Li-drift detectors. The measurements were made at 77°K where the mobility is limited by impurity scattering rather than lattice scattering. The mobility was measured as a function of temperature for five samples of Ge which had varying Li drift mobilities. Good correlation was found between the driftability of the material and the minority-carrier drift mobility at 77°K. Estimated impurity levels in the range of 10^{14}–10^{15}/cm^3 apparently reduce the effective Li mobility, while impurity concentrations greater than 5×10^{15} make the Ge unsuitable for making lithium-drift detectors. A mass-spectrometer analysis indicated that the impurity apparently has a mass number less than Mg; oxygen is a likely possibility due to its known behavior with Li in Si. (auth)

33686 ENERGY-SENSITIVE THIN-FILM COUNTERS FOR ULTRA-RELATIVISTIC PARTICLES. Inman, F. W. (Univ. of the Pacific, Stockton, Calif.); Muray, J. J. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 373-9(June 1966).

The problem of devising energy-dependent detectors for the ultra-relativistic region is discussed from the viewpoint of thin-film devices. Ionization loss, secondary electron emission, and transition radiation are proposed as mechanisms for producing an energy-dependent signal from thin films. (auth)

33687 GAS-FILLED AVALANCHE OR SPARK-PRODUCING IMAGE-INTENSIFIER DETECTOR FOR X AND γ RAYS. Lansiart, A.; Morucci, J. P.; Roux, G. (Commissariat a l'Energie Atomique, Saclay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 393-8(June 1966).

A gas-filled detector for the visualization of radioactivity collected in human organs was developed. Several modifications and refinements of the detector are discussed. (G.O.Y.)

33688 PARTICLE VELOCITY MEASUREMENTS MADE BY OBSERVING CHERENKOV RING IMAGES WITH IMAGE INTENSIFIERS. Iredale, P.; Hinder, G. W.; Parham, A. G.; Ryden, D. J. (Atomic Energy Research Establishment, Harwell, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 399-406(June 1966).

Ring images produced by a lens from Čerenkov radiation were observed by using an image-intensifier system. As a result of the passage of a single fast particle through the Čerenkov radiator, a photograph of the output of the system shows a ring image defined by some 12 to 26 spots, the precise number varying according to the conditions. The calculated number, and the distribution in number, of spots is shown to be in agreement with the experimental results. A least squares method is used to fit a circle to the set of points defining a ring. The least squares method used is of an unorthodox nature, and its performance is checked by a simulation program in which points representing a ring are generated by a computer. It is found that the accuracy in determining ring radius for the experimental rings is similar to that for the computer-simulated ones. (auth)

33689 LARGE-AREA LIQUID SCINTILLATION DETECTOR SLAB. Crouch, M. F.; Gurr, H. S.; Hruschka, A. A.; Jenkins, T. L.; Kropp, W. R.; Reines, F.; Sobel, H. (Case Inst. of Tech., Cleveland). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 424-31 (June 1966).

A detector developed for underground cosmic-ray neutrino experiments is described. The liquid used is a high-clarity mineral oil-based mixture, and light is guided to the ends of the detector by total internal reflection at the surface of the lucite container. Signals from 2 five-inch photomultipliers at each end give energy and event location for single penetrating particles, with relatively good discrimination against natural radioactivity by virtue of the substantial thickness. Data are presented on the response function of the tank, energy resolution, rates, and thresholds. A number of modifications that have been tried are also described. (auth)

33690 SYSTEM FOR RECORDING SIGNAL AMPLITUDES AND WAVEFORMS FROM A LARGE-AREA SCINTILLATION COUNTER HODOSCOPE. Crouch, M. F.; Gurr, H. S.; Kropp, W. R.; Meyer, B.; Reines, F. (Case Inst. of Tech., Cleveland). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 432-7(June 1966).

A low-speed modification of the chronotron was adapted to recording data from an array of 144 photomultiplier tubes. By noting the kinds of combinations of signals expected for the various physical events of interest, a relatively simple pulse position code is devised to display the data. This display gives addresses and amplitudes of signals for a composite event and in addition permits the determination of whether the waveforms are bona fide in nature or spurious. Some degree of redundancy may also be incorporated into the system. (auth)

33691 DIGITAL PULSE-HEIGHT RECORDING FOR A LARGE MULTIPLE SCINTILLATION DETECTOR ARRAY USING AN ANALOG BUFFER MEMORY. Shoffner, B. M.; Jenkins, T. L. (Case Inst. of Tech., Cleveland). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 438-44(June 1966).

A method used to record the events from a large multiple-scintillation detector is described. The principle of the system is to store pulses, which occur simultaneously in up to 144 phototubes, in analog form as charges on individual capacitors. Subsequent to the actual detection of the event, the charges on the capacitors are measured and their values are digitized in sequence. The resulting numbers, which represent the original pulse heights, are stored in serial fashion in the memory of a pulse-height analyzer. The information in the analyzer is then printed and the system is readied for another event. (G.O.Y.)

33692 INSTRUMENTAL REQUIREMENTS FOR HIGH-RESOLUTION GAMMA-RAY SPECTROMETRY USING LITHIUM-DRIFTED GERMANIUM DETECTORS. Heath, R. L.; Black, W. W.; Cline, J. E. (Phillips Petroleum Co., Idaho Falls, Idaho). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 445-56(June 1966).

Some recent measurements of the Fano factor, obtained with a 4096-channel analog-to-digital converter, are summarized. Techniques are described for the measurement of system linearity, stability, and dynamic performance of spectrometers under changing experimental conditions. The evaluation of analog-to-digital converters has included their use both with conventional hard-wired pulse analyzers and programed data processors. Precision pulse generators, methods for measurement of system linearity, and computer programs for data analysis developed to obtain precision values for energies and intensities of gamma rays in complex pulse-height spectra are described. Data are presented to demonstrate the precisions which can be obtained with equipment presently available. Design criteria for pulse-height analyzers and amplifiers for use with germanium detectors are discussed. (auth)

33693 WIDE-BAND LOW-NOISE CHARGE-SENSITIVE PREAMPLIFIER. Blalock, T. V. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 457-67(June 1966). (ORNL-P-2037).

The design considerations and experimental characteristics are presented for a transistorized charge-sensitive preamplifier that has a noise line-width significantly lower than that of the best vacuum-tube preamplifiers, and a high gain-bandwidth product which allows stabilization of the charge gain against detector capacitance fluctuations over a wide range of pulse-shaping time-constants. The open-loop gain of both the input charge-sensitive section and the output cable driver section is sufficiently stabilized against temperature fluctuations by compensating elements to allow the feedback capacitor in the charge-sensitive section to control the gain drift of the entire preamplifier. (auth)

33694 LOW-NOISE CHARGE-SENSITIVE PREAMPLIFIER FOR SEMICONDUCTOR DETECTORS USING PARALLELED FIELD-EFFECT-TRANSISTORS. Smith, K. F.; Cline, J. E. (Phillips Petroleum Co., Idaho Falls, Idaho). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 468-76(June 1966).

A low-noise preamplifier with provisions for paralleling field-effect transistors (FET) in the input stage is described. Considerable improvement in the resolution vs capacitance slope is obtained by using several paralleled transistors rather than a single FET. Theoretical calculations of the resolution are in excellent agreement with the experimental results. (G.O.Y.)

33695 NEW CONCEPTS IN NUCLEAR PULSE AMPLIFIER DESIGN. Blankenship, J. L.; Nowlin, C. H. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 495-507 (June 1966). (ORNL-P-2163).

An experimental pulse amplifier that closely approximates desirable overall transfer functions is described. The amplifier consists of broadband, fixed-feedback amplifiers, and a passive, linear lumped-element network.

The gain of the amplifier is adjusted by passive, constant-impedance attenuators. This amplifier was evaluated for overload recovery, crossover walk, pile-up distortion, common mode rejection, and noise-to-signal ratio. (G.O.Y.)

33696 IMPROVED PARTICLE IDENTIFIER FOR STUDIES OF LOW-YIELD NUCLEAR REACTIONS. Goulding, F. S.; Landis, D. A.; Cerny, J.; Pehl, R. H. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 514-26 (June 1966).

An identifier is described in which two ΔE detectors are employed; each time a particle passes through the counter telescope two identifications are made, each using one of the ΔE signals. If they do not agree with each other within prescribed limits (due to one of the ΔE signals deviating from normal) the event is completely rejected. Fast coincidence and pile-up rejector techniques are used to reduce the effects of chance coincidences between unrelated detector signals, and a fourth counter is used to reject high-energy particles which pass completely through the telescope. Details of the instrument and its performance in several experiments are given, and the general problems in this type of work are also discussed. (auth)

33697 BACKGROUND REDUCTION IN CHARGED-PARTICLE SPECTROSCOPY WITH FAST-GATED ELECTRONICS. Katzenstein, Henry S. (Solid State Radiations, Inc., Los Angeles). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 527-36 (June 1966).

Some efforts to exploit the short collection times available from the present generation of detectors to permit the selection of relevant events on a fast time scale with subsequent slow encoding of the events for storage and readout are summarized. (D.C.W.)

33698 SIGNAL PROCESSOR RECOVERY TIME EFFECTS ON PHOTON COUNTING ACCURACY, OBSERVED COUNTS, AND TRUE EVENTS. Richard, Herbert L. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 537-40 (June 1966).

The response time of the signal processor is examined from the standpoint of the trade-offs that can be made in defining the data accuracy in terms of the signal processor recovery time, observed counts, standard deviation, and required number of data scaler bits. Curves are shown from which, for different values of recovery time, the true event rate can be determined at an observed count rate. Other curves show the relation between data scaler bit levels and resultant data accuracy at different standard deviations. (auth)

33699 DESIGN CRITERIA FOR WIDE-RANGE GAMMA RADIACS USING SEMICONDUCTOR DIODE DETECTORS. Wesley, E. J.; Joseph, W. F. (Naval Radiological Defense Lab., San Francisco). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 541-52 (June 1966).

The application of silicon semiconductor detectors to a wide-range, gamma dose-rate meter using the detectors in a pulse counting mode is discussed. Pertinent circuit and detector characteristics that establish the dose-rate ranges that can be covered, the energy dependence to be expected from both large lithium-drifted detectors and very small silicon junction diodes, and finally the stability requirements imposed on the electronics by the pulse mode of operation are reviewed. Methods of tailoring the photon energy response of semiconductor detectors are also reviewed with particular attention given to the effect on design of amplifier and detector noise and variations in the noise level. The conclusion is supported that it is practical to make a survey meter, using silicon semiconductor detectors, that covers both the health physics and high dose-rate ranges of interest in military radiac design. (auth).

33700 ZONE SELECTION IN MULTIPARAMETER ANALYSIS. Hooton, I. N. (United Kingdom Atomic Energy Authority, Harwell, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 553-8 (June 1966). (AERE-R-5133).

It is shown that the costs of associative analysis may be reduced by taking advantage of the fact that in many experiments information occurs in groups or clusters of channels. This is achieved by the zone-selection technique. The experimental field is divided into zones of adjacent channels and it is then only necessary to store the addresses of the active zones in the associative mode, the individual channels within the zone being defined conventionally. The overall system is then equivalent to conventional analysis with digital windows automatically set to the active zones while no storage space is used for inactive regions of the spectrum. A general formula is derived for the performance of any system in relation to the zone and cluster sizes. The technique is applied to both hardware systems. (G.O.Y.)

33701 CONTENTS ADDRESSABLE ANALYZER FOR ONE MILLION CHANNELS. Best, G. C.; Hickman, S. A.; Hooton, I. N.; Prior, G. M. (United Kingdom Atomic Energy Authority, Harwell, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 559-65 (June 1966).

A hardware analyzer based on the zone selection technique was constructed. It has an input dead time of 10 μ seconds and will analyze 4096 channels in 256 zones of 16 channels from a million channel fields. (auth)

33702 ASSOCIATIVE STORAGE WITH A SMALL COMPUTER. Best, G. C. (United Kingdom Atomic Energy Authority, Harwell, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 566-70 (June 1966).

A small computer (PDP8) was used as an associative analyzer by utilizing the zone selection technique. The 4096-word 12-bit store operated associatively with 128 zones of 16 channels. There was a total of 2048 counting channels, each of 18 bits, so that 75% of the store is directly occupied with experimental data. The main input rate is more than 10,000 descriptors per sec, with a pair resolution of 10 μsec. Live maps and isomeric displays are incorporated. (G.O.Y.)

33703 NOMOGRAPHIC DETERMINATION OF THE RELATIVE STATISTICAL ERROR OF NORMALIZED NUCLEAR RADIATION COUNTING RATES. Winkler, K. (Institut fuer Physikalische Chemie, Berlin). Kernenergie, 9: 133-40 (Apr. 1966). (In German).

The general equations for calculating the relative statistical error of variable normalized counting rates are derived for three methods of counting. The counting methods are compared. Nomograms for two of the methods are presented. (G.O.Y.)

33704 EXPERIMENTAL HUMAN-BODY COUNTER OF THE STAATLICHE ZENTRALE FUER STRAHLENSCHUTZ. Poulheim, K.-F.; Hoesselbarth, H. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie, 9: 140-7 (Apr. 1966). (In German).

The first whole-body counter in the German Democratic Republic is described, including the electronic equipment and the measurement geometries used. The statistical error of measurements with the counter is determined. (D.C.W.)

33705 THE SPARK CHAMBER. PART II. Truemper, J. (Christian-Albrechts-Univ., Kiel). Kerntechnik, 8: 230-5 (May 1966).

Spark chambers differing in construction and operation from ordinary spark chambers are described. Filmless spark chambers are discussed. The essential properties of spark chambers are compared with other particle-track detectors. (J.S.R.)

33706 RADIOMETRY OF LOW ACTIVITIES. Dementev, V. A.; Furman, A. O. Med. Radiol., 11: No. 5, 61-8 (May 1966). (In Russian).

Measurement of low activities is of special importance for controlling radioactive contaminations. Greatest accuracy may be achieved on the basis of the formula $A_{min} = (1 + 2\delta\ VT\ N_b)/(2.22\delta^2 TF) \cdot 10^{-12}$ c, correlating the minimum activity A_{min} that may be measured with a certain

accuracy δ for a period T, given in minutes, at a recording efficiency F for the radiation in question and a background N_b, given in pulses/minute. The formula indicates that A_{min} depends on the N_b/F ratio; i.e., the recording efficiency F is a more important factor than the background rate. Most instrument designers try to reduce the background count, although it might be better to improve the counting efficiency. It is of interest to note that contemporary lead, used for shielding counting instruments, has a relatively high activity of about 350 disintegrations/minute per 100 g, while the 16th century lead is about ten times less active. Iron is less contaminated, therefore steel shields are quite suitable for instruments designed for measuring low activities. Mercury is also contaminated, but electrolytic copper is very pure. The most efficient instruments for β radiation are the 2π and 4π counters because their efficiency is independent of the energy of the β radiation. The advantages and problems presented by the various instruments used for measuring low-activity radiations are examined on the basis of recent literature data. (TTT)

33707 400-CHANNEL PULSE-HEIGHT ANALYZER (ND-1666). Kurahashi, Kuichiro (Mitsubishi Electric Manufacturing Co., Ltd., Tokyo); Masui, Takao. Mitsubishi Denki Giho, 40: 389-96(Feb. 1966). (In Japanese).

A 400-channel pulse height analyzer is described that differs from the conventional ones on the following points: (1) Provided with the Mitsubishi Molectron, it has high reliability and compactness. (2) Self containing the arithmetic function, it permits easy analysis of the spectrum. (3) Baseline shift is performed digitally. (4) Clear observation is made by the live display. (auth)

33708 ^{110m}Ag CONTAMINATION IN SCINTILLATION DETECTOR SHIELDING. Reynolds, E. (Ministry of Agriculture, Fisheries and Food, Lowestoft, Eng.). Nature, 210: 615-16(May 7, 1966).

The source of a ^{110m}Ag contamination in a lead assembly for shielding NaI (Th activated) γ detectors is investigated. A conclusion was reached that the contamination was present in the lead prior to its mining, and that the ^{110m}Ag was probably used for tracer studies of the efficiency of silver extraction processes. (B.G.D.)

33709 IN-PILE DOSIMETRY. Hayakawa, Sohachiro (Tokyo Inst. of Tech.). Nippon Genshiryoku Gakkaishi, 8: 317-26(June 1966). (In Japanese).

Methods and procedures available for measuring dose and dose rate of neutrons, γ rays, and other nuclear radiations in nuclear reactors are reviewed. The importance of in-pile dosimetry has hitherto been emphasized in radiation chemistry and biology, as well as in radiation damage research. Nevertheless it has not so far appeared hopeful to find an ideal method satisfying all the conditions demanded of in-pile dosimetry. Some convenient procedures that should enable dosimetric measurements to be compared and discussed internationally as well as within one country are proposed. (auth)

33710 MEASURING RADIONUCLIDE DISTRIBUTION WITH CROSSED-WIRE SPARK CHAMBERS. Pullan, B. R.; Howard, R.; Perry, B. J. (St. George's Hospital, London). Nucleonics, 24: No. 7, 72-5(July 1966).

A crossed-wire spark chamber that can record rapidly numerical as well as pictorial information was developed in order to determine the distribution of beta and gamma-emitting nuclides. The design of this spark chamber and the data extraction for beta emission and gamma scanning are described. (J.F.P.)

33711 FLUCTUATION DURING STABILIZATION OF AMPLIFICATION OF SCINTILLATION COUNTERS BY USING AN α-SOURCE FOR REFERENCE PULSES. Fogt, P. N. Sb. Geofiz. Priborostr., 19: 53-60(1964). (In Russian).

A radioactive source can be used as a source of standard light pulses in obtaining a high stability of the energy threshold of present scintillation counters. One of the disadvantages of a radioactive source of standard pulses is the random distribution of pulses with time results in additional fluctuations of the useful signal because of the stabilization circuit. These fluctuations are estimated for a circuit containing a photomultiplier and a linear pulse amplifier, an amplitude discriminator in the stabilization system, a circuit converting pulse intensity at the discriminator outlet to voltage, an amplifying tube, and a discriminator and pulse intensity converter in the measuring channel. The relative transmission coefficient is estimated for each step in terms of the network parameters. Examples are given for calculating the amplification coefficient, the equivalent time constant of the stabilization network, and the relative fluctuations in the amplification coefficient. (TTT)

33712 LITHIUM-DRIFTED GERMANIUM DETECTORS. Terada, Jitsuo; Takayanagi, Seiichi (Shibaura Electric Co., Ltd., Tokyo). Toshiba Rebyu, 21: 176-82(Feb. 1966). (In Japanese).

Encapsulated lithium-drifted germanium detectors have been developed with gamma resolution of 3.2 kev at 122 kev. A simple cryostat assembly for the encapsulated detectors has also been studied. The detector is mounted on a cold finger and is surrounded by polystyrene insulation. A hole is drilled at the center of the cold finger to exhaust dry nitrogen gas when the cold finger is dipped in liquid nitrogen. This dry nitrogen flow prevents frosting of the case and electrical connection to the detector. This assembly dispenses with the use of a vacuum system and works satisfactorily for 40 days under normal ambient conditions. The detectors have been used to make high-resolution studies of complex gamma spectra. (auth)

33713 ANALYSIS OF A DIGITAL ANGER CAMERA SYSTEM WITH THREE-DIMENSIONAL RESOLUTION FOR POSITRON EMITTERS. Kenny, Peter J.; Lundy, A.; Laughlin, J. S. (Sloan-Kettering Inst. for Cancer Research, New York). Trans. Amer. Nucl. Soc., 9: 75-6 (June 1966).

33714 DEVELOPMENT AND EVALUATION OF A LARGE DETECTOR MULTIDIMENSIONAL GAMMA-RAY SPECTROMETER. Wogman, N. A.; Robertson, D. E.; Perkins, R. W. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 91(June 1966).

33715 DIRECT COMPARISON OF ^{6}Li SEMICONDUCTOR AND PROTON-RECOIL FAST-NEUTRON SPECTROMETERS. Huber, R. J. (Argonne National Lab., Idaho Falls, Idaho); Bennett, E. F. Trans. Amer. Nucl. Soc., 9: 91-2(June 1966).

33716 STOPPING POWER OF NUCLEAR TRACK EMULSIONS PRODUCED IN THE USSR. Zhdanov, A. P.; Skirda, N. V. Zh. Nauch. Prikl. Fotogr. Kinematogr., 10: 330-43(1965). (In Russian).

This is a study of braking or stopping power of nuclear track emulsions. It is concerned with the uniformity of emulsion stopping power, batch-to-batch, individually, and locally, and motivated by the present use of emulsions as measuring devices for particle energies. The elementary emulsion stopping power is the ratio, dE/dR, of particle energy loss, dE, over an element of range, dR, to the element of track of range dR, in the emulsion. The total range, R, is $R = \int_E^0 (dE/dR)^{-1} dE$. The ionization theory of heavy particle braking process within the emulsion leads to the stopping power equation: $-dE/dR = 2\pi nz^2e^4(\ln(2m\beta^2c^2E'_m/I^2(Z)(1-\beta^2) - U(\beta) - \delta(\beta))/m.\beta^2.c^2$. This shows that, at given magnitudes of particles "β" and charge (ze), the stopping power depends only upon the chemical composition of the emulsion, which also determines I(Z), the average ionization potential of the braking environment, the electron volume density (n = NZ), and E'_m, the maximum energy transferable from the particle to an encountered electron. U(β) and δ(β) are (small) corrections for the polarization effect (the last expression) and exchange energy. Therefore, conclusions about stopping power uniformity can be made from an evaluation of chemical composition varia-

tions, in addition to the experimental evaluation of track range statistics, or independently. It is found that proportion coefficients of compounds forming the standardized NIKFI-BR emulsion have a standard deviation comparable with that of the extensively studied Ilford G-5 emulsion. A simple and adequate method of stopping power evaluation is proposed, requiring determination of only three quantities: the silver halides content, emulsion density, and emulsion relative humidity. It is found that several other nuclear emulsions have insufficient stopping power uniformity requiring often batch and individual emulsion calibrations. In this connection, a method for a fast determination of particle range vs energy for emulsion calibration is proposed, based upon the interpolation formula $E = kR^a$. It is shown that the determination of two values for each constant, two pairs (k_1,a_1) and (k_2,a_2), are sufficient for approximating the R-E curve over a range of 7–900 Mev. The first pair of constants (k_1,a_1) can be obtained from range measurements of monoenergetic neutrons of the t(d,n)He^4 nuclear reaction, $E_n = 14.1$ Mev and μ-mesons due to the decay of π + mesons with E = 4.12 Mev, $\beta = .27$. The second pair determination requires irradiations by an accelerator. (ATD)

33717 USE OF RETARDATION OF THE DEVELOPMENT PROCESS IN FILM DOSIMETRY. Kubal, Y. (Inst. of Nuclear Studies, Prague). Zh. Nauch. Prikl. Fotogr. Kinematogr., 11: 90-4(Mar.-Apr. 1966). (In Russian).

The dependence of relative sensitivity on the concentration of benzotriazole for a metol hydroquinone developer was examined. For developing time of 8 min, the relative sensitivity was found to be: 0 g/l, 450; 1 g/l, 100; 2 g/l, 10. For 20 min, sensitivities were: 1 g/l, 140; 2 g/l, 80; 3 g/l, 50. The dependence of optical density (o.d.) on the dose from a ^{60}Co source, using a metol hydroquinone developer with different concentrations of benzotriazole, was determined. The extent of fogging with different concentrations of stabilizers and the dependence of fogging on developing time, using metol hydroquinone, was studied. (TCO)

33718 DEVELOPMENT OF HIGH RESOLUTION GAMMA RAY SPECTROSCOPY FOR USE WITH THE UNIVERSITY OF COLORADO CYCLOTRON. Henning, Peter. Boulder, Colo., Univ. of Colorado, 1965. 116p. Thesis.

A curved crystal spectrometer was built at the University of Colorado for the precision measurement of gamma rays in an energy range of 35 kev to 2 Mev. The (422) planes of a germanium crystal plate are used to Bragg reflect the gamma rays being measured. The resolution, which is linear in energy, has a measured value of $R = 2.8 \times 10^{-5}$ E(kev), which results from a constant line width of 0.35 milliangstroms. Measurements of gamma-ray lines were made in the first three orders of the (422) planes and with energies of 42 kev to 1222 kev. A dispersion of 1.13 ma per mm is obtained. The reflectivity is found to compare favorably with predicted values showing a λ^2 dependence. Diffraction from planes normal to the surface of a bent crystal plate is treated with emphasis on the determination of line widths. A description of components of the spectrometer is given. The operation of a lithium-drifted germanium detector for gamma rays is described, particularly relating its measurements to those of the crystal spectrometer. A relative efficiency curve is obtained for the germanium detector and comparison made to a linear absorption curve for germanium. Observation of diffraction from a supposedly forbidden set of planes is described in some detail. Finally results are presented on the investigation of various radioisotopes in the A = 181 – 194 area with a discussion of two previously unreported lines in tungsten-182 and four in tungsten-183. A search for gamma rays from osmium-194, produced by second order neutron capture, indicated that any gamma-ray activity was either too low in energy or in intensity to be observed. Radioisotopes of osmium and rhenium were produced by (p,xn) reactions in tungsten and rhenium foils and the decay gamma rays following positron emission or electron capture were analyzed with the crystal spectrometer. (Dissertation Abstr.)

33719 APPLICATION OF DOSIMETRY BY THERMOLUMINESCENCE TO HEALTH PHYSICS. Cluchet, J.; Joffre, H. 22p. (CONF-650637–10). ORAU. Gmelin, AED-CONF-65-151-21.

From International Conference on Luminescent Dosimetry, Palo Alto, Calif.

The physical problems of photon dosimetry for the exact evaluation of the biological risks are discussed for any energy between 10 kev and 10 Mev. The conditions which must be satisfied by the detecting medium and the materials in contact with it (e.g., outside wall) are derived. Applied to thermoluminescence dosimetry, these principles lead to the choice of compounds of low atomic number (LiF, $Li_2B_4O_7$) for a detecting medium. It is also necessary to study carefully the thickness and the composition of the walls and materials making up the dosimeter. (auth)

33720 PROGRESS IN NUCLEAR ELECTRONICS. Costrell, Louis (National Bureau of Standards, Washington, D. C.). 21p. (CONF-660207–4). ORAU. Gmelin, AED-CONF-66-011-2.

From Radioisotope Applications in Aerospace Symposium, Dayton, Ohio.

A brief history of the development of radiation detection instruments and associated equipment is presented. (C.E.S.)

33721 CHARGING APPARATUS FOR DOSIMETER. Bryer, Robert George (to R. A. Stephen and Co. Ltd.). German Patent 1,213,930. Apr. 7, 1966. Priority date Oct. 9, 1962, Great Britain.

The dosimeter charging unit comprises a casing provided with a well adapted to receive the end of a dosimeter. Extending upwardly in the center of the well is a post constructed of two concentric contact electrodes spaced from each other by an insulator member. In order to facilitate the charging of dosimeters of different dimensions, the outer, resilient contact ring is provided with portions of different diameter. (Gmelin Inst.)

33722 LOW BACKGROUND NUCLEAR RADIATION DETECTOR. Woodworth, Victor C.; Leone, James E. (to Lab. for Electronics, Inc.). U. S. Patent 3,250,937. May 10, 1966. Filed Jan. 22, 1962.

A low background detector for small amounts of beta radiation employs a nested pair of flow gas counters with the inner counter serving as a source counter and the outer as an anti-coincidence guard counter. A thin window is provided on one surface of the source counter for exposure to the radioactive material to be measured, and the remainder of the cathode of the source counter serves as a portion of the cathode of the surrounding guard counter. Gas is flowed serially through the center source counter, then through the anti-coincidence guard counter before discharge into the atmosphere. The geometric configuration of the source counter, which is formed as a truncated cone with the beta window forming the base of the cone, provides both high efficiency for a single anode guard counter and a minimum practical area for the source counter in terms of contribution from contaminants of the construction materials of the source counter. The entire unit is easily assembled and disassembled and virtually eliminates problems of gas flow between the two counters, as well as simplifies electrical connections. (B.L.M.)

33723 SCINTILLATION COUNTER FOR NEUTRONS AND GAMMA RAYS. Youmans, Arthur H. (to Dresser Industries, Inc.). U. S. Patent 3,254,217. May 31, 1966. Filed Dec. 14, 1950.

A scintillation counter is described for use in well logging for the detection of neutrons and/or gamma rays. The counter is combined with the usual well logging apparatus with the exception that another scintillation counter that is sensitive to gamma rays only is included in the subsurface portion of the apparatus. The signals from both counters are transmitted to the surface where the two signals are subtracted (the signal from the gamma ray counter subtracted from that of the neutron and gamma ray detector), and the resultant signal is recorded and correlated with the

depth of the drill hole at which the counters were subjected to radiation. (B.L.M.)

33724 ENERGETIC CHARGED-PARTICLE DETECTOR. Madey, Richard (to Fairchild Hiller Corp.). U. S. Patent 3,254,220. May 31, 1966. Filed Jan. 28, 1963.

A radiation detector comprises a number of adjacent, conducting plates electrically insulated and spaced from each other. The space between each pair of adjacent plates is filled with a gas. A source of relatively high voltage is connected to alternate plates, while a ground connection is provided to the other plates. The voltage is of a selected value to produce a current discharge between adjacent pairs of the plates upon the passage of an energetic charged particle into the space. A sensor disposed between each pair of adjacent plates is responsive to the current discharge between the plates so that the penetrating power of the particle is determined. Each pair of the plates is separated by annular spacers fabricated of dielectric material, and the plates and spacers are encapsulated in a dielectric material. The detector is particularly applicable to use in outer space exploration. (B.L.M.)

33725 ^{12}B BETA DECAY NEUTRON DETECTOR. Garlick, Geroge F.; Bunch, Wilbur L. (to U. S. Atomic Energy Commission). U. S. Patent 3,259,745. July 5, 1966.

A device for measuring neutron flux is described. A body of boron, enriched in the isotope boron-11, is irradiated. The boron-11, upon neutron capture, transmutes to boron-12 which has a half-life in the order of 20 microseconds. As the boron-12 decays to carbon-12 with the emission of a beta particle, the device measures the resulting current which is representative of the neutron flux. The slow burnup of boron-11 insures a prolonged life for the device. (AEC)

Radiation Effects

Refer also to abstracts 34353 and 34778.

33726 (N-65-32169) ANNEALING OF INFRARED DEFECT ABSORPTION BANDS IN 40-Mev ELECTRON-IRRADIATED SILICON. Corelli, J. C.; Oehler, G.; Becker, J. F.; Eisentraut, K. J. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science). [1964]. 21p. (NASA-CR-59212). CFSTI $1.00 cy, $0.50 mn.

Oxygen containing n- and p-type silicon (100Ω – cm) and floating-zone n-type silicon (0.1Ω – cm) were irradiated by 44 Mev electrons at 40°C to total integrated fluxes of 1 – 2 × 10^{18} e/cm^2. The floating-zone silicon remained n-type (2500Ω – cm) after irradiation and exhibited infrared defect absorption bands at 1.8 μ and when cooled to 85°K defect bands at 3.46 and 3.62 μ appeared. The oxygen-containing silicon was n-type after irradiation with resistivity of 3 × 10^5Ω – cm and exhibited bands at 11.6 μ and 12 μ in addition to the 1.8, 3.46, and 3.62 μ bands. Isochronal annealing studies indicated that 1.8, 3.46, and 3.62 μ bands anneal out together and are completely removed in all samples by heat treatment to 300°C. The 11.6 and 12 μ bands do not begin to anneal out until a temperature of 300°C is reached and are completely gone at 400°C. At temperatures above 375°C a new band at 11.2 μ appears only in oxygen-containing silicon having maximum intensity at 475°C and then disappears at 575°C. (auth)

33727 (N-66-10647) CARRIER LIFETIME MEASUREMENTS AND RECOMBINATION CHARACTERISTICS IN SILICON AND STUDIES PHENOMENA ASSOCIATED WITH RADIATION-INDUCED DEFECT LEVELS. Downing, R. G. (Space Technology Labs., Inc., Redondo Beach, Calif.). Aug. 20, 1965. Contract NAS5-3805. 2p. (NASA-CR-67631). CFSTI $1.00 cy, $0.50 mn.

Minority carrier lifetime measurements in silicon were decided to be of vital importance in determining recombination characteristics in silicon. It was also agreed that considerable effort should be expended on the annealing characteristics of radiation-induced defect levels, and the effect of different dopant materials on radiation-induced defect levels. Annealing studies were made on the E_v + 0.3 ev and on the E_c – 0.17 ev levels. The repeated efforts showed that the E_v + 0.3 ev does not anneal to any extent at 400°C or lower. Material used in these studies had a high resistivity, low dislocation, and was crucible grown. (STAR)

33728 (N-66-11201) EFFECTS OF GAMMA RADIATION ON SCR'S USED IN SWITCHING MODE AND IN APPLICATION TO ATTITUDE CONTROL MOTOR DRIVE BRIDGE. Smith, Gail D. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 18, 1965. 19p. (NASA-TM-X-55305; X-636-65-241). CFSTI $1.00 cy, $0.50 mn.

A study of the effect of cobalt-60 gamma radiation upon silicon controlled rectifiers (SCR) during repetitive pulsing is presented. Six electrical characteristics of each SCR were tested before, during, and after radiation exposure. All of these characteristics are shown graphically as a function of the total accumulated dose with the SCR's both in and out of the radiation field. These curves reveal appreciable changes in the characteristics with total accumulated dose and some evidence of dose rate effect. It is concluded that all observed changes are within design capability. That is, SCR circuits can be designed to reliably perform the desired functions in a gamma field of 2 × 10^6 rads per hour for a total dose of 6.6 × 10^6 rads. (auth)

33729 (N-66-12189) STUDY OF DRIFT-FIELD SOLAR CELLS DAMAGED BY LOW-ENERGY PROTONS, SEPTEMBER 10–OCTOBER 15, 1965. DePangher, J.; Breuch, R. A.; Crowther, D. L. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Contract NAS5-9627. 23p. (NASA-CR-68159). CFSTI $1.00 cy, $0.50 mn.

Current-voltage data, and spectral response data for 30 drift-field solar cells and 12 uniform solar cells irradiated by .221 kev, .470 kev, 1.04 Mev, and 2.53 Mev protons, were analyzed. A computer program was developed to fit the modified diode equation to four points on an I-V curve and to obtain completed I-V curves for the various irradiation energies. Degradation of all I-V curves with increasing proton fluence was evident. An analysis of I-V data obtained for solar cells irradiated by 1.04 Mev protons is given. (STAR)

33730 (N-66-12193) STUDY OF DRIFT-FIELD SOLAR CELLS DAMAGED BY LOW-ENERGY PROTONS, JUNE 15-AUGUST 10, 1965. DePangher, J.; Lodi, E. A. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Contract NAS5-9627. 7p. (NASA-CR-68158). CFSTI $1.00 cy, $0.50 mn.

During the period June 15 through August 10, 1965, considerable effort was made to calibrate the irradiation apparatus and the counting equipment to find the cause of discrepancy in the calibration of the 60° and the 120° monitor for measuring proton fluences. Pulse height distribution data, uniformity data, and data obtained at different count rates are being analyzed. Solar cells were soldered to small copper blocks, and current-voltage curves as well as spectral response curves were obtained prior to the anticipated irradiation with 2.8 Mev protons. (STAR)

33731 (N-66-13174) DEFECT ANNEALING IN IRRADIATED SEMICONDUCTORS. Progress Report, April 1–September 30, 1965. Pritchard, W. Maurice (Old Dominion Coll., Norfolk, Va. Dept. of Physics). Oct. 1, 1965. 13p. (NASA-CR-68458). CFSTI $1.00 cy, $0.50 mn.

The possibility of obtaining exact analytic solutions of the general annealing equations with one secondary defect complex was further investigated. It was found that the problem of finding exact analytic solutions is equivalent to the problem of solving the Abelian equation, for which no standard technique exists. Development of approximate solutions of the annealing equations with one secondary defect complex was also undertaken, with a partially linear-

ized version of the primary equation considered. In order to obtain the fraction of defects not annealed, it was necessary to integrate the equation used to find the annealing plateau level for a particular set of model parameters. A computer program was written to perform the integration. (STAR)

33732 (N-66-16985) A STUDY OF THE RELIABILITY OF ELECTRONIC COMPONENTS IN A NUCLEAR-RADIATION ENVIRONMENT. Quarterly Report No. 12, October 1-December 31, 1965. Hanks, C. L.; Hamman, D. J. (Battelle Memorial Inst., Columbus, Ohio). Jan. 13, 1966. Contracts NAS7-100; JPL-950458. 14p. (NASA-CR-70172). CFSTI $1.00 cy, $0.50 mn.

For Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

The 8000 hour parameter measurements on all capacitors, transistors, and diodes in the seven test groups were completed, and the 9000 hour measurements were begun. The components in test groups III, V, and VI have now accumulated a total of 8000 hours of nuclear irradiation. Total neutron and gamma exposure at 8000 hours is given for these same three groups. Group V has received 6.2×10^{12} n/cm^2 and 8.35×10^8 ergs/g; groups III and VI have received 7.3×10^{12} n/cm^2 and 8.30×10^8 ergs/g. All component failures which have occurred since 7000 hours are listed along with their respective causes. (STAR)

33733 (N-66-17104) A STUDY OF THE RELIABILITY OF ELECTRONIC COMPONENTS IN A NUCLEAR-RADIATION ENVIRONMENT. Quarterly Report No. 11, July 1-September 30, 1965. Hanks, C. L.; Hamman, D. J. (Battelle Memorial Inst., Columbus, Ohio). Oct. 15, 1965. Contracts NAS7-100; JPL-950458. 14p. (NASA-CR-68841). CFSTI $1.00 cy, $0.50 mn.

For Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

Life tests on electronic components subjected to a nuclear radiation environment are reported. These components include capacitors, diodes, controlled rectifiers, and transistors. Tables are given of component parts which have indicated failure, approximate neutron and gamma exposures with irradiation periods of up to 7000 hours, and components indicating catastrophic failure. (STAR)

33734 RADIATION EFFECTS ON SILICON SOLAR CELLS. Wood, O. Lew (Imperial-Eastman Corp., Salt Lake City). Electro-Technol. (N. Y.), 77: 52-4(Apr. 1966).

The nature of high-energy radiation-induced defects in p-on-n silicon solar cells is explained. The degradation in short-circuit current caused by radiation damage is considered. In experiments which are described, silicon solar cells were irradiated to simulate Van Allen and cosmic radiation. As the cells become damaged by radiation, there is a strong decrease in the short-circuit current, and the open-circuit voltage drops slightly. Variations in maximum power output with integrated electron and proton flux are shown. For a high-efficiency p-on-n silicon solar cell, an integrated flux of 5×10^{13} electrons/cm^2 or 5×10^{10} protons/cm^2 causes a 25% decrease in the power output. A change in the spectral response of a solar cell accompanies a decrease in its output power. Deterioration is the most rapid in the ir region since the major radiation damage is in the bulk silicon. The lifetime of the minority carriers in the bulk silicon is reduced by the radiation defects, since they trap the carriers before they can be separated at the junction. The radiation-resistant n-on-p solar cell has a boron-doped p-type base and a phosphorous-diffused n-type surface layer. The electric characteristics and conversion efficiency of the n-on-p cell are comparable to those of the p-on-n cell but the n-on-p cells have a significantly greater radiation resistance. (TCO)

33735 CATASTROPHIC FAILURES IN SEMICONDUCTOR DEVICES EXPOSED TO PULSED RADIATION. Landis, DeWitt (Lockheed Palo Alto Research Lab., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 591-600(June 1966).

Semiconductor devices were exposed to high intensity 1.6 Mev electron pulses. Glass diode packages and integrated circuit chips were broken. However, the failure occurring at the lowest radiation doses is lead-chip separation at the point at which the lead is bonded to the chip. Statistical experiments show that the damage is caused by energy absorption in the device. The failure probability is calculated. A technique based on absorbed doses and differential temperature rises is suggested to correlate the results with other environments. (auth)

33736 PHOTOMULTIPLIER STUDY OF BURST PULSE CORONA IN AIR. Nakaya, Toshizo (Hungnam Univ., Japan). Mem. Konan Univ., Sci. Ser., No. 8, 25-44(Aug. 1965).

The size distribution of photopulses in a d-c positive corona discharge was recorded as a function of applied voltage. Measurements were made in the regions of intermittent corona and steady burst pulse corona, and the effects of external radiation on the corona characteristics were examined. The characteristics of intermittent burst pulse corona were observed to change into what resembled a steady corona when the corona gap was irradiated with beta, uv, or alpha rays. (auth)

33737 SEMICONDUCTOR PERFORMANCE UNDER INTENSE TRANSIENT RADIATION. Andrew, A.; Smith, E. A.; Landis, D. (Lockheed Aircraft Corp., Palo Alto, Calif.). Trans. Amer. Nucl. Soc., 9: 56-7(June 1966).

33738 EFFECT OF IONIZING RADIATION ON THE BREAKDOWN POTENTIALS OF AIR GAPS. Vol'f, E. M. Zh. Tekh. Fiz., 36: 564-5(Mar. 1966). (In Russian).

Breakdown potentials of air gaps in the presence of gamma and slow neutron radiation from a pile were measured in order to obtain engineering data for design of electronic equipment for service in high radiation environments. Both d-c and a-c breakdown were investigated for gaps between spherical electrodes and between a point and a plane electrode; in the d-c point to plane measurements the point was positive. The gamma intensity ranged from 2.5 to 25,000 r/sec and the neutron intensity from 2×10^9 to 2×10^{13} slow neutrons/cm^2 sec. The maximum ionization rate and ion density were 5.2×10^{13} cm^{-3} sec^{-1} and 5.6×10^9 cm^{-3}, respectively. The gap lengths are not given, but the breakdown potentials at low radiation intensities ranged from 3.2 kv (a-c sphere gap) to 7.4 kv (positive point to plane). The a-c and d-c breakdown potentials of the sphere gap decreased monotonically with increasing radiation intensity; the breakdown potential under the most intense radiation was only some 20% below its values with no radiation. The breakdown potential of the point to plane gap decreased rapidly with increasing radiation intensity, reached a minimum at 100-200 r/sec, and increased with further increase of the radiation intensity. The minimum d-c breakdown potential of the point to plane gap was nearly 40% below its no radiation value. It is suggested that the initial decrease in the breakdown potential with increasing radiation intensity may be due to diffusion of electrons to the point electrode resulting in formation of a region of positive space charge; in more intense radiation fields the space charge gradient would be reduced by the presence of a higher concentration of negative charges and the breakdown; potential would again increase. (ATD)

33739 HIGH FIELD CONDUCTIVITY STUDIES OF N-GERMANIUM IRRADIATED AT 4.2 DEG K. Callcott, Thomas Anderson. Lafayette, Ind., Purdue Univ., 1965. 126p.

Thesis.

Hot carrier conductivity measurements are used to monitor damage introduced by energetic electrons into n-germanium at 4.2°K. Measurements are made during short pulses (<1 sec) to limit lattice heating to a few degrees above 4.2°K. Pulse conductivity measurements for fields ranging from 10 to 200 volts/cm provide essentially the same information obtained from combined d-c conductivity and Hall effect measurements. In addition, it is possible to measure, as a function of pulse field, the times required by two types of defects to capture conduction band

electrons. The magnitude of this cross section and its variation with carrier energy identifies the charge states of these defects. Three types of defects are identified. One anneals in a temperature range near 65°K in both pure and degenerate samples. It is shown that the defect captures a conduction band electron (presumably its stabilizing electron) with a small cross section ($\leq 10^{-18}$ cm^2) that increases with carrier energy. This magnitude and energy dependence indicates capture of a second electron by a negative defect, and shows the defect to be a double acceptor. Two types of defects remain after annealing the 65°K defect. One, produced at a rate independent of total flux, accounts for about 5% of the total damage at 0.7 Mev and about 50% at 4.5 Mev. The dependence of its introduction rate on bombardment energy suggests that it is a divacancy or a divacancy with associated interstitials. A second permanent defect, observed only after large fluxes ($>10^{15}$ cm^{-2}), is observed in the pure samples after bombardments of energy <0.6 Mev. It is thought to be formed from the 65°K defect when subsequent irradiation causes a further separation of that close-spaced pair. This defect shares with the 65°K defect the property of having a capture cross section for conduction band electrons that indicates it is a double acceptor. (TCO)

ISOTOPE TECHNOLOGY

General

33740 IONIZING RADIATION AND LIGHTNING HAZARDS. Roberts J. E. (Middlesex Hospital Medical School, London); Ramsey, N. W.; Gillespie, P. J. Nature, 210: 514-15(Apr. 30, 1966).

Comments are presented on a previous paper by Gillespie (Nature, 208: 577(1965)) on radioactive sources for lightning protection. A reply to these comments is also included. (B.G.D.)

33741 OPYT RABOTY BAZOVOI IZOTOPNOI LABORATORII. (Operation of a Basic Isotope Laboratory). Gerchikov, D. S. Moscow, Atomizdat, 1966. 76p.

The operation of the basic isotope laboratory of Donbas for the incorporation of radioisotope methods in industry is elucidated. The organization of the laboratory, methods of working with radioactive isotopes, and perspectives for introducing them further are described. (tr-auth)

33742 RADIOISOTOPE TECHNIQUES. Overman, Ralph T.; Clark, Herbert M. New York, McGraw-Hill Book Co., Inc., 1960. 488p.

The book is a guide for teaching and studying techniques for handling radioactive materials, performing proper and significant measurements of radioactivity, and interpreting the data as well as the theory behind these techniques. Subjects covered are: nuclear radiations and their interactions with matter, detection of radiation, errors in radioactivity measurements, practice of radiological safety, preparation of radioactive sources, laboratory characterization of radiation, standardization of radioactive sources and calibration of radiation detectors, rates of radioactive processes, radiochemical separation methods, and utilization of radioisotopes. (D.H.M.)

Industrial Applications

Refer also to abstract 33382.

33743 (TID-22774) COMMERCIALIZATION OF THE PROCESS OF MANUFACTURING RADIATION-PRODUCED PLASTIC-IMPREGNATED WOOD IN THE SOUTHERN REGION. (Southern Interstate Nuclear Board, Atlanta, Ga.). Mar. 1966. Contract AT(38-1)-402. 111p. (SR-119). Dep. mn. CFSTI $1.25 cy, $0.75 mn.

Results of investigations are presented concerning effects of new materials on products of wood-plastics-combination (WPC) processes. The studies were conducted to define the steps necessary to achieve commercialization of WPC processes and to evaluate southeastern U.S. sites for WPC facilities. Project activities, findings, and recommendations are summarized. (J.R.D.)

33744 INDUCED ACTIVITY OF NUCLEAR ISOMERS ORIGINATED IN CONSERVATION OF FOODS BY IRRADIATION IN THE ENERGY RANGE BELOW 10 Mev. Tuchscheerer, T. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Atomkernenergie, 11: 333-8(July-Aug. 1966). (In German).

Irradiation conditions are described, for which the magnitude of induced radioactivity by irradiation of food is determined by the activation of isomers only. At energy levels below 10 Mev and for dose values of 5 Mrad the most interesting process is the activation of the ^{107m}Ag-(^{109m}Ag-) isomer. The order of magnitude of maximal activation is 10^{-6} $\mu Ci/g_{food}$. The theoretical activation value is confirmed by experiments. (auth)

33745 INDUSTRIAL IRRADIATION. PRESENT SITUATION. POSSIBILITIES OFFERED FOR THE CONSERVATION OF FOODS. Rondenay, F. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), Suppl., No. 59, 6-10 (May-June 1966). (In French).

The future of preservation of food materials by industrial irradiation was reviewed. The biological effects and the organoleptic modifications induced in the foods are tabulated. The commercial authorizations for food preservation granted by the various countries are listed. The French installations for food preservation studies are described. (J.S.R.)

33746 SELECTION-GENETIC STUDY OF PEAR HYBRIDS AND WORK TOWARD PRODUCTION OF NEW VARIETIES. Yakovlev, S. P. (Michurin Central Genetics Lab., Michurinsk, USSR). Genetika, No. 2, 101-14(Feb. 1966). (In Russian).

Data obtained during a seven-year study on breeding hybrid pears, and methods of pear breeding are reported. Regularities are stated concerning inheritance by the progeny of basic properties and traits of the initial forms, which are most important for partial genetics of the pear and its selection. For instance, it was found that winter-hardiness of the hybrids and quality of their fruit most often are inherited independently from each other while the character of transmission of these traits depends on the initial forms. The best cultural sorts (Klapp's favorite, Olivier de Serre, and others) were produced as well as local pear forms suitable for subsequent breeding of new sorts of this kind. A general scheme of selection of initial parent pairs for hybridization as well as some results of the application of ionizing radiation in pear breeding are presented. (P.C.H.)

33747 INDUCED RADIOACTIVITY IN FOOD AND ELECTRON STERILIZATION. Meyer, Richard A. (Army Natick Labs., Mass.). Health Phys., 12: 1027-37(Aug. 1966).

An extensive survey of the literature was made on activity induced in foods by the use of high energy electrons. This survey indicates that food irradiated with 24-Mev electrons contains less than a 5 per cent increase in the radioactivity level present before irradiation. Through a compilation of the experimentally measured amount of activity induced in various foods as a function of initial electron energy, an equation has been developed which will predict the average amount of induced activity as a function of initial electron energy, dosage and elemental abundance. This equation yields results within the variation of trace elements in foods. (auth)

33748 STUDY ON THE MATURATION CHANGE IN FRUITS INDUCED BY GAMMA IRRADIATION. PART I. EFFECTS OF GAMMA RADIATION ON THE AFTER-RIPENING AND QUALITY OF BANANA FRUIT. Chachin, Kazuo; Kato, Katsuichi (Osaka Univ.). Nippon Shokuhiu Kogyo Gakkaishi, 12: 367-72(Sept. 1965). (In Japanese).

Studies were made of the effects of gamma radiation on ripening, post-harvest physiology, and quality of bananas irradiated at doses from 0.5 to 5×10^4 R at three stages: pre-climacteric (green), climacteric onset (yellowish green), and post-climacteric (greenish yellow). The irradiated fruit turned brown irrespective of the stages. The contents of chlorophyl and polyphenol in the peel were decreased by the irradiation, and polyphenoloxidase activity was higher in the irradiated brown fruit. Carbon dioxide evolution increased sharply immediately after irradiation. When green bananas were irradiated with 5×10^4 R, the climacteric rise of respiration was delayed. The increasing effect of DNP and pyruvate addition on the respiration of slices of both peel and pulp was lower in the irradiated fruit. While the pulp softened under irradiation, the sugar content and emanation of volatile constituents were suppressed, and the acceptability was lower. (auth)

33749 RADIOISOTOPE APPLICATIONS. Nucl. Eng., 11: 377-9(May 1966).

The use of radioisotopes in chemical processing, food treatment, wood/plastic irradiation, power supplies, and light sources is briefly discussed with emphasis on current development activities. (D.C.W.)

33750 WOOD GOES ATOMIC. Yoshioka, Ruby. Sci. News Lett., 87: 394-5(June 19, 1965).

The development of polymer-impregnated wood, produced by γ irradiation of wood soaked in monomer, with improved qualities is described. The wood to be treated is cut into appropriate lengths and thicknesses and vacuum-impregnated or pressure-impregnated in a solution of suitable liquid monomer. After soaking, the saturated wood is packaged to help prevent monomer evaporation. The encased wood is then exposed to radiation, such as from a cobalt-60 source. During the impregnation, the plastic-forming monomer penetrates the porous wood, filling the tiny spaces in the cells of the wood. When the molecules are irradiated, they become linked to each other throughout the wood, forming a network of polymer that envelopes the cells and encloses them in a tight seal of hard plastic. This plastic-reinforced wood, taking on some of the qualities of the plastic impregnated in it, absorbs water more slowly than untreated wood and is more resistant to blows and scratches. Large sections and non-uniform woods can be treated rapidly with uniformity with γ rays. Although most of the research has been done with white and yellow pine, sugar maple, white oak, and birch, almost any wood can be converted into the wood-plastic combination. (TCO)

33751 HEAT GENERATION IN GAMMA-RADIATION TARGETS. Fallon, P. T.; Kuhl, O. A. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 73(June 1966).

Power Application

See also ENGINEERING — Space Propulsion

Refer also to abstracts 33749, 33759, and 35128.

33752 (N-66-12928) RADIOISOTOPE HEAT SOURCE EVALUATION PROGRAM. Final Report, May 15–December 13, 1964. (Cook Technological Center, Morton Grove, Ill.). Contract NAS5-3849. 246p. (NASA-CR-68182). CFSTI $6.00 cy, $1.50 mn.

The primary objective of the radioisotope heat source evaluation program was the compilation of an annotated bibliography on the nuclear characteristics of the following isotopes: strontium-90, cesium-134, cesium–barium-137, promethium-147, polonium-210, plutonium-238, curium-242, and curium-244. A secondary objective of the program was the generation of a Fortran computer program capable of computing the low energy bremsstrahlung (< 250 kev) emanated by candidate isotopic fuels. Promethium-147 was used as a typical radioisotope. At the beginning of each isotope section, the best values for the nuclear characteristics of that isotope are presented. These characteristics are: half life, spontaneous fission half life (when applicable), energy levels, decay schemes, spins, alphas/spontaneous fission (when applicable), and neutrons/spontaneous fission (when applicable). The bremsstrahlung computer program was tested using promethium-147 oxide as a typical case. In addition to the program proper a flow diagram of the program is presented along with graphs of the generated bremsstrahlung spectrum. (auth)

33753 RADIOISOTOPE POWER GENERATING SYSTEM FOR A MANNED SPACE LABORATORY. Tonelli, A. Duane; Regnier, Edward P. (Douglas Aircraft Co., Santa Monica, Calif.). J. Eng. Ind., 88: 129-41(May 1966).

An exploratory study of radioisotope secondary power generating systems for space applications is presented. The results are applicable to various space vehicles and missions requiring 4 kw or more of electrical power. The first generation of manned vehicles where a radioisotope power system is potentially applicable include the Extended Apollo and MOL-type earth-orbiting laboratories. For this reason, the results were applied to selecting a radioisotope power system for a small manned orbiting lab. The lab considered is capable of being launched in the post-1968 time period by a Titan 3C booster. The argon Brayton cycle, Dowtherm A Rankine cycle, and thermoelectric systems were investigated as possible secondary power systems capable of generating 4 kw of electric power for the vehicle subsystems. Comparisons were made of weight, radiator area requirement, development risk and isotope availability, and cost for the various systems. On the basis of the tradeoffs and the 4-kw design load, the argon Brayton cycle system was recommended. The Dowtherm A Rankine cycle system is competitive with the Brayton cycle system from a weight minimum radiator area, and cost standpoint. However, there is less of a development risk associated with the Brayton system than with the Rankine system for the post-1968 lab. The optimum radioisotope for the heat source material from a cost and availability standpoint is ^{210}Po; its half-life is 138 days and it could be used for the 120-day mission. An acceptable weight penalty of 100 to 150 lb is incurred by the use of ^{210}Po as compared to ^{238}Pu. The radioisotope power system could also be used for unmanned interplanetary probes, lunar orbiting vehicles and communications satellites. Mission durations of one year or more would require ^{238}Pu instead of ^{210}Po as the heat source material. (BBB)

33754 USE OF ^{16}O WITH ^{238}Pu TO REDUCE NEUTRON YIELD. Keshishian, Vahe; Broom, Knox M. Jr. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 102(June 1966).

33755 REQUIREMENTS ORIENTED RISK REDUCTION. Harper, W. T. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc., 9: 161(June 1966).

33756 APPLICATION OF THE SNAP-27 RADIOISOTOPE POWER GENERATOR TO THE APOLLO MISSION. Cohen, R. M. (General Electric Co., Philadelphia). Trans. Amer. Nucl. Soc., 9: 164-5(June 1966).

33757 GENERATION OF ELECTRICITY BY RADIOACTIVE WASTES. Gumucio, Ricardo Salcedo; Bockris, John O'M. (to Yardney International Corp.). U. S. Patent 3,250,925. May 10, 1966. Filed July 12, 1961.

A method is described for generating an electric current by immersing a pair of juxtaposed electrodes in a liquid electrolyte containing radioemissive substances capable of alpha, beta, and gamma emission. The first electrode is cathodically connected and the second electrode is anodically connected in an external circuit to derive an electric current upon decay of the radioemissive substance and interception of electrically charged particles produced upon such decay by the electrodes. The body of electrolyte has a radioactive gradient or such a gradient is imposed by means of a shielding arrangement so that part of the liquid has a higher intensity of radioactivity and one electrode is positioned in this region of higher intensity while the other electrode is positioned in a region of lower intensity. (B.L.M.)

Separation and Production

See also CHEMISTRY — Separation Processes and Procedures

Refer also to abstract 34614.

33758 ^{57}Co YIELDS IN CYCLOTRON. Krasnov, N. N.; Dmitriev, P. P. At. Energ. (USSR), 20: 57-9(Jan. 1966). (In Russian).

There is a great demand for ^{57}Co in connection with the many studies on the Mössbauer effect. Three methods of preparation of this isotope by nuclear reactions were

examined. They include: 1. irradiation of iron by deuterons, $^{56}Fe(d,n)^{57}Co$; 2. irradiation of nickel by protons, $^{58}Ni(p,2p)^{57}Co$; $^{58}Ni(p,pn)^{57}Ni \rightarrow {}^{57}Co$; $^{58}Ni(p,2n)^{57}Cu \rightarrow {}^{57}Ni \rightarrow {}^{57}Co$; $^{60}Ni(p,\alpha)^{57}Co$; and 3. irradiation of Ni by α particles, $^{58}Ni(\alpha,\alpha p)^{57}Co$; $^{58}Ni(\alpha,\alpha n)^{57}Ni \rightarrow {}^{57}Co$. The dependence of the total ^{57}Co yield on the total energy of the particles was examined by determining the absolute ^{57}Co activity of specially shielded iron and nickel foils, on the basis of the photopeak of the 126-kev γ line. Activity measurements were also made on Co separated from the targets a few months after the irradiation. In cyclotron preparation of isotopes, in addition to the actual yield, the permissible power level of the incident beam must also be taken into account; therefore, the results were expressed not only in $\mu C/\mu amp.$ hr units, but also in $\mu C/kwh$. It was found that irradiation of nickel with 22-Mev protons is the most efficient reaction for preparing ^{57}Co. In the proton irradiation of nickel, ^{55}Fe is also formed according to the reaction $^{58}Ni(p,\alpha)^{55}Co \rightarrow {}^{55}Fe$; it may be removed from the mixture. Irradiation of Mn with α particles yields a product containing relatively large amounts of ^{56}Co and ^{58}Co; similar difficulties arise in the irradiation of Fe with α particles and of Ni with deuterons. (TTT)

33759 POSSIBILITIES OF MANUFACTURING THE ACTINIDE ELEMENTS USABLE AS HEAT SOURCE IN ISOTOPIC POWER GENERATORS. Berger, R. Bull. Inform. Sci. Tech. (Paris), No. 104, 35-63(May 1966). (In French).

The factors involved in a potential manufacture of the actinide elements usable as heat sources in isotopic power generators are reviewed. They include raw materials availability and recovery means, irradiation possibilities, chemical process efficiency and conditioning method development. This study shows that industrial production of the isotopes ^{227}Ac, ^{228}Th, ^{232}U, ^{238}Pu, ^{242}Cm, and ^{244}Cm can be performed by target irradiation in nuclear reactors. (auth)

33760 SEPARATION OF ISOTOPES. Blum, Jacques M. Energ. Nucl., 8: 207-11(May 1966). (In French).

A bibliographic review is presented on the chemical and physical methods of isotope separation. Topics covered include: statistically reversible procedures, statistically irreversible procedures, and separation by specific methods (photochemical and electromagnetic methods). (78 references). (J.S.R.)

33761 ECONOMIC ASPECTS OF INDUSTRIAL PRODUCTION OF HEAVY WATER. Malasek, Eduard; Zoch, Oldrich. Jad. Energ., 12: 166-71(1966). (In Czech).

The Czechoslovakian nuclear power program is based on heavy water reactors, and their development places high demands on the supply of heavy water. Studies showed that the price of heavy water, to a significant degree, is dependent on the price of electrical energy produced in nuclear power plants. A brief evaluation is given of the commercial methods for the production of heavy water. (tr-auth)

33762 DEVELOPMENT OF MEDICAL RADIONUCLIDES AT ORNL. Hupf, Homer B. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 81-2 (June 1966).

33763 PRODUCTION OF CARRIER-FREE RADIOACTIVE ISOTOPES WITH THE UNIVERSITY OF PITTSBURGH CYCLOTRON. Allen, A. J.; Cohen, B. L.; Yuska, R.; Eiben, D. (Univ. of Pittsburgh). Trans. Amer. Nucl. Soc., 9: 82(June 1966).

33764 SPECTROSCOPIC AND SPALLATION STUDIES WITH THE ORSAY SEPARATOR. Kilcher, P.; Poffe, N.; Albouy, G.; (and others) (Laboratoire Joliot-Curie de Physique Nucleaire, Orsay, France). 8p. (CONF-578-18). ORAU.

From Conference on the Physics of Electromagnetic Separation Methods, Orsay, France, July 1962.

Separation techniques using the Orsay separator are described. These techniques are used for spectroscopic studies of deformed nuclei in the area of the rare earths, and nuclei in the intermediate region between Nilsson and the spherical nuclei zones. These techniques are also used for spallation studies. Some results from previous experiments are given. (J.F.P.)

MATHEMATICS AND COMPUTERS

33765 OBSERVATIONS ON VECTOR INTEGRALS. Schweiger, Fritz (Univ., Vienna). Acta Phys. Austr., 21: 389-94(1966). (In German).

Some results concerned with the Laplace-Lenz vector were reported. A method was then given that makes it possible to derive the conservation of the angular momentum simultaneously with the conservation of the Laplace-Lenz vector. The harmonic oscillator was considered. (tr-auth)

33766 LIST RETRIEVAL FOR COMPUTER-ASSOCIATIVE ANALYZERS. Soucek, Branko (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 571-7(June 1966).

The features of the tree-search and the hash-coding techniques are compared. The use of a small computer as a hybrid associative analyzer is described, in which a standard analysis is performed on parameter X and an associative analysis on parameter Y. This technique allows more than 80% of the memory to be devoted to the count list. (G.O.Y.)

33767 SPACES OF VALUE FUNCTIONS IN A SEMI-NORM LINEAR SPACE. De Wilde, M. Mem. Soc. Roy. Sci. Liege, 13: No. 2, 1-198(1966). (In French).

A systematic and complete study is presented of spaces of defined functions in a euclidian space and with value in a semi-norm linear space. The applications to the usual function spaces of several variables are considered. (J.S.R.)

33768 ANALOGUE OF THE GALILEI GROUP. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 44A: 512-17(July 21, 1966).

The group of space-time transformations $r' = Ar$, $t' = t - (u \cdot r)$, which is analog to the Galilei group with the role of space and time interchanged, was studied (u is a reciprocal velocity and A represents a space rotation). The relation between this group and the Lorentz groups was investigated. (auth)

33769 DISCONTINUOUS TRIAL FUNCTIONS. Wachspress, E. L. (General Electric Co., Schenectady, N. Y.). Trans. Amer. Nucl. Soc., 9: 200(June 1966).

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstracts 34871 and 34872.

33770 (GEMP-59A) HIGH-TEMPERATURE MATERIALS PROGRAM PROGRESS REPORT NO. 59, PART A. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). May 31, 1966. Contract AT(40-1)-2847. 66p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Laboratory testing of Fe-Cr-Al-Y-clad Fe-UO_2 fueled specimens was continued at 750, 950, and 1100°C in air. Three specimens clad with 2541 alloy were in good condition and had limited U concentration on the cladding surface after completing 10,000 hours of testing at 1100°C. Two in-pile tests of 1541-clad Fe-40UO_2 specimens were completed. Experiment LTFC-3 was conducted in the LITR at 950°C for 2406 hours in flowing air; no fission gas release was detected. Experiment ORFC-1 was operated in the ORR for 731 hours at indicated temperature of 730°C and to a burnup of 3.5%. An increase in fission product release after 400 hr is attributed to a localized temperature excursion which caused incipient melting in the cladding alloy. Ductility evaluations of a series of Fe-Cr-Al-Y alloys which were in oxidation tests for as long as 10,000 hr show that the alloys containing 25% Cr age-harden at 450 and 550°C and are brittle at room temperature. The stress-rupture and creep characteristics of arc-cast W-25Re sheet were determined in H_2 at 1600 to 2600°C. The ductility of the W-25Re, based on the strain at rupture, was found to be a maximum at 1850°C. Additional creep-rupture tests of powder metallurgy W-Re-Mo sheet for compositions ranging from W-18Re-10Mo to W-27Re-30Mo were performed at 1600 and 2200°C. The results indicate a significant decrease in the ductility of the ternary alloys in the region of the phase boundary. Studies dealing with the analysis of combined first-, second-, and third-stage creep data for arc-cast W at 2400°C were made using four different expressions. The effectiveness of the modified deLacombe equation does not appear to be much better than the t^3 or deLacombe equations for stresses below 1.05 kg/mm^2, but at this stress the modified deLacombe equation in expressing the creep curve is superior. Metallographic and Laue back-reflection diffraction studies of arc-cast W, creep tested at 1800 and 2400°C, were made. At 1800°C, coarse and fine slip bands are very evident with some grains showing a network of cross-slip lines. At 2400°C, cell formation becomes predominant with the large subgrains or cells outlined by rows of dislocations. The thermal conductivity of W-20UO_2 (vol%) was determined at 620 to 2300°C. Data were also obtained for W-40UO_2 (vol%) at 400 to 900°C. Studies were performed on the compatibility of CaO with W, W-5Re, and Ta at 2450°C for 1 hour in H_2 and in a carbonaceous H environment. Tungsten and W-5Re were found to be compatible with CaO in H_2 but not in carbonaceous H. Ta and CaO appear to be compatible in both environments at 2450°C. The thermoelectric signal from a W-3Re/W-25Re thermocouple using synthesized alloys to represent 6 months in a 10^{14} nvt thermal neutron flux has larger induced errors at low temperature and smaller errors at high temperature than the W/W-25Re thermocouple. The ductility of welded Mo sheet processed with purification techniques developed in this program was confirmed. Good ductility and weldability were also observed in Mo sheet containing minor Re and W additions if purification techniques to remove C and O_2 were used. Studies of the influence of stress-relief treatments at 1425 to 1700°C on the ductility of W-30Re-30Mo sheet showed that the preferred structure and ductility were achieved at 1650 to 1700°C. (J.R.D.)

33771 (LA-3495) BEHAVIOR OF LIQUID Pu-Co-Ce ALLOYS IN CONTACT WITH SODIUM. I. OUT-OF-PILE FUEL PIN VENTING EXPERIMENTS. Clifford, J. C. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Mar. 15, 1966. Contract W-7405-eng-36. 12p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

To help determine the feasibility of venting fission gasses from fuel capsules in sodium-liquid plutonium alloy fast reactor systems, open Ta capsules containing Pu-Co-Ce fuel were exposed to flowing Na at 650°C. These experiments revealed that fuel climbs up the walls of annealed Ta capsules, leading to measurable fuel losses within 1000 to 3000 hr. Co depletion in the climbing fuel (because of Ta-Co intermetallic compound formation at the capsule walls) leaves Pu-Ce residues which are more corrosive than the original fuel. The use of a carbide layer on capsule inside surfaces ameliorates these conditions to some, as yet undefined, extent. (auth)

33772 ANNUAL SURVEY AND OUTLOOK: MINOR METALS: URANIUM. Sherman, John (Atomic Industrial Forum Inc., New York). Eng. Mining J., 167: 108-11 (Feb. 1966).

Uranium reserves in the U. S. on Jan. 1, 1966 were estimated to be 61.6 million short tons of ore containing 0.235% U_3O_8 or 145,000 tons of U_3O_8. Net additions to reserves during the year, resulting from re-evaluations, discoveries, and extensions of known ore-bodies, amounted to about 3600 tons of U_3O_8, only partially offsetting deliveries to mills of about 10,600 tons. Projected (1971, 1975, 1980) estimates of annual world and U. S. needs are given, based on an initial inventory for light water reactors of from 0.7 short tons of U_3O_8 to 1.0 ton per Mwe of installed nuclear capacity and an annual make-up of from 0.13 to 0.16 short tons of U_3O_8 for each Mwe capacity. U. S. utilities announced the purchase of seven reactors during 1965, with 4000 tons of U_3O_8 being required for the initial charges for these reactors and another 14,000 tons to replace ^{235}U consumed over the life of these reactors. In fiscal year 1965 AEC purchases of U_3O_8 amounted to $265 million as compared to $328 million in 1964. The cost per pound of U_3O_8 from U. S. producers averaged $8.03, from Canadian producers $8.73, and from South African producers $11.08 for an average cost of $8.65 compared to an average cost of $8.79 in 1964. Foreign developments are also reviewed. (BBB)

33773 ANNUAL SURVEY AND OUTLOOK: MINOR METALS: ZIRCONIUM AND HAFNIUM. Parker, John G. (Bureau of Mines, Washington, D. C.). Eng. Mining J., 167: 111-12(Feb. 1966).

Increasing demand for zircon in 1965 was reflected in greatly increased domestic and foreign mine production. U. S. companies in Florida shipped over 50% more zircon concentrate, and Australian beach sand mining firms produced over 10% more, than in 1964. Zirconium metal production decreased slightly, and hafnium oxide and sponge output also decreased. Research efforts by metal and alloy producers were devoted mostly to developing newer zirconium- and hafnium-based alloys with high strength and high temperature qualities, particularly those suited for use in nuclear applications. Although production of zirconium metal and alloys consumed a minor quantity of zircon, these materials with very low neutron-capture cross section and high corrosion resistance, are important construction materials in fuel element cladding in naval nuclear reactors and, although expensive, are receiving more attention in commercial power reactors. Hafnium metal, with a very high neutron cross section, is extremely good in reactor control rods but, as with zirconium, relatively high prices have encouraged substitutes. (BBB)

33774 ANNUAL SURVEY AND OUTLOOK: MINOR METALS: THORIUM. Baroch, Charles T. (Bureau of

Mines, Washington, D. C.). Eng. Mining J., 167: 113-15 (Feb. 1966).

In 1965, production capacity of thorium was far in excess of demand, and apparent consumption was at about the same level as in the previous three years. Nonnuclear demand remained steady, while nuclear uses continued to be experimental only and were largely supplied from inventory stocks held by the Atomic Energy Commission. Progress in the adoption of thorium in nuclear reactors was slow. Domestic production of thorium in 1965 was about 30% below that of 1964. World production of thorium minerals showed little change from 1964. For the first 10 months of 1965, imports totaled 1750 short tons of monazite, almost 18% greater than for the same period of 1964. In a discussion of nuclear developments it is pointed out that the large-scale use of thorium will come in the future with the development of breeder reactors, which can be designed to use either uranium or thorium. Neither ^{238}U nor ^{232}Th are fissionable, but when irradiated by neutrons in a reactor, they are converted into fissionable elements. The $^{232}Th-^{233}U$ type breeder reactor is of great interest because thorium is more abundant than uranium and because of certain more favorable technical factors. (BBB)

33775 CANADIAN MINERAL INDUSTRY IN 1965: URANIUM. Simpson, R. A. (Dept. of Mines and Technical Surveys, Ottawa). Mineral Inform. Bull., MR 81: 49-50(1966).

Primarily because of lack of markets, in 1965 the Canadian uranium industry suffered its sixth consecutive annual decline in output. Total shipments were only 4300 tons of U_3O_8 in 1965 compared to 16,000 tons in 1959. At $64,000,000, the 1965 output value was less than one-fifth of the peak year's value. Only four companies produced uranium in 1965. The Canadian Government decided in June 1965 to purchase uranium from companies that had previously produced uranium. Purchases may be made up to maximum stipulated quantities for a period of five years, from July 1, 1965. The program will allow companies to maintain their mines and plants in a condition to meet the expected production challenge of the future. The Government's program will permit the industry as a whole to produce for the next five years at roughly 4000 tons a year at a price of $4.90 per pound of U_3O_8. The Government also established a policy for promoting the future use of uranium. It announced that it would grant export permits with respect to sales of uranium only if the uranium is to be used solely for peaceful purposes. (TCO)

33776 COMMERCIAL PLUTONIUM BUSINESS. Puechl, Karl H. Nucl. Eng., 11: 366-8(May 1966).

The development of the commercial plutonium business is discussed with consideration of the influence of Pu toxicity, Pu cost, and the industry's immaturity. Cost-reduction mechanisms are also considered. (G.O.Y.)

33777 JABROC 'N' AND SIZEWELL. Bishop, D. R.; McDonald, A. Nucl. Eng., 11: 387-9(May 1966).

The use of Jabroc "N" as neutron shielding is briefly discussed with specific consideration of the shielding of the Sizewell fueling machine. Design techniques and shield optimization are briefly considered. (D.C.W.)

33778 PROGRESS IN THE DEVELOPMENT OF FAST-REACTOR METAL FUELS. O'Boyle, D. R.; Rhude, H. V.; Blumenthal, B. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 1(June 1966).

33779 SOLUBILITIES OF REFRACTORY ELEMENTS IN LIQUID PLUTONIUM. Bowersox, D. F.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 7(June 1966).

33780 TECHNOLOGY AND PERFORMANCE OF LANTHANIDE OXIDE NEUTRON ABSORBERS. Leitten, C. F. Jr.; Beaver, R. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 10(June 1966).

33781 MATERIALS, FABRICATION, AND DESIGN FEASIBILITY STUDY FOR A HIGH-TEMPERATURE, UNCOOLED, ARTICULATING CONTROL ROD. Baxter, W. G.; Tenhundfeld, J. W. (General Electric Co., Cincinnati). Trans. Amer. Nucl. Soc., 9: 12-13(June 1966).

33782 PREPARATION AND NATURE OF RARE-EARTH HYDROXIDE SOLS, AND IMPLICATIONS ON TRANSPLUTONIUM ELEMENT OXIDES. Buxton, S. R.; Hardy, C. J.; Lloyd, M. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 14(June 1966).

33783 HIGH-DENSITY BeO FOR NUCLEAR FUEL APPLICATIONS ABOVE 1100 DEG C. Meyer, Robert A., Lofftus, Fred H.; Goodjohn, Albert J. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 16-17(June 1966).

33784 COMPATIBILITY OF MODIFIED MONOCARBIDE FUELS WITH STAINLESS STEEL. Herbst, R. J.; Jordan, K. R. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 17-18(June 1966).

33785 THERMAL DECOMPOSITION OF PLUTONIUM PEROXIDE. Moseley, J. D.; Robinson, H. N. (Dow Chemical Co., Golden, Colo.). Trans. Amer. Nucl. Soc., 9: 20-1(June 1966).

33786 ADVANCES IN PLUTONIUM-REDUCTION TECHNOLOGY. Conner, William V. (Dow Chemical Co., Golden, Colo.). Trans. Amer. Nucl. Soc., 9: 21 (June 1966).

33787 UO_2–STEAM REACTION AT 1500 DEG C. Wilson, R. E.; Baker, L. Jr.; Barnes, C. Jr. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 24 (June 1966).

33788 COMPATIBILITY OF UO_2 WITH W-25 Re FOR NUCLEAR THERMIONICS. Ekvall, R. A. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 9: 24-5(June 1966).

33789 SINTERING STUDIES AND PHASE CHARACTERIZATION IN THE SYSTEM Eu_2O_3–UO_2. Hill, H. W.; Lewis, J. E.; Grossman, L. N. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 9: 25-6 (June 1966).

33790 SAXTON PLUTONIUM PROJECT MATERIALS PROGRAM. Allio, R. J.; Biancheria, A.; Ray, W. E. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 29-30(June 1966).

33791 IN-PILE EXPERIENCE WITH ZIRCALOY-CLAD FUEL RODS IN A BORATED PWR ENVIRONMENT. McClintock, D. R. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 32-3(June 1966).

33792 BEHAVIOR OF SENSITIZED STAINLESS STEEL IN A PRESSURIZED WATER REACTOR. Stanutz, R. N.; McClintock, D. R.; Hazelton, W. S. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 33-4(June 1966).

33793 RECENT DEVELOPMENTS IN HIGH-TEMPERATURE PLUTONIUM COMPOUNDS. Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 37(June 1966).

33794 URANIUM–PLUTONIUM MONONITRIDE FUEL MATERIALS FOR FAST REACTORS. Pardue, W. M.; Smith, R. A.; Rough, F. A. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc., 9: 37(June 1966).

33795 COMPATIBILITY OF OXIDE FUELS [UO_{2+x} AND $(Pu,U)O_{2+x}$] WITH SODIUM AND NaK. Knight, F. W.; Hendricksen, W. A.; O'Neill, G. L.; Lyon, W. L. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 9: 37-9(June 1966).

33796 PREPARATION AND PROPERTIES OF PLUTONIUM CARBONITRIDE. Guyton, J. L. (Silas Mason

Hanger, Amarillo, Tex.); Thompson, M. A. Trans. Amer. Nucl. Soc., 9: 39-40(June 1966).

33797 EFFECT OF DIAMETRAL GAP SIZE ON THE IN-PILE PERFORMANCE OF FAST CERAMIC REACTOR MIXED-OXIDE FUEL. Baily, W. E.; Craig, C. N.; Zebroski, E. L. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 9: 40(June 1966).

33798 SHORT-TERM FAST-FLUX (EBR-II) IRRADIATION OF PuO_2–UO_2 FUEL PINS. Rabin, S. A.; Darmitzel, R. W.; Kendall, W. W. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 9: 41-2(June 1966).

33799 IRRADIATION PERFORMANCE OF UN–20 PuN FUELS AT HIGH HEAT RATINGS AND BURNUPS. Christensen, J. A.; Hinman, C. A.; Carroll, D. F. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 42-3(June 1966).

33800 PROSPECTS FOR ZIRCONIUM-ALLOY COOLANT TUBES IN ORGANIC-COOLED REACTORS. Thexton, H. E.; Wilkins, B. J. S.; Trupp, A. C.; Sawatzky, A. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Trans. Amer. Nucl. Soc., 9: 46(June 1966).

33801 UC FUELS IN ORGANIC-COOLED REACTORS. Mathers, W. G. (Atomic Energy of Canada Ltd., Pinawa, Manitoba); MacDonald, R. D.; May, J. E.; Tachis, A. M. Trans. Amer. Nucl. Soc., 9: 46-7(June 1966).

33802 UO_2 FUELS IN ORGANIC-COOLED REACTORS. Hart, R. G.; Oldaker, I. E.; Thexton, H. E.; Walker, J. F. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Trans. Amer. Nucl. Soc., 9: 47-8(June 1966).

33803 MODEL SODIUM-HEATED STEAM-GENERATOR MATERIALS STUDIES. Campbell, T. M.; Koch, D. W.; Kovach, P. J. (Babcock and Wilcox Co., Alliance, Ohio). Trans. Amer. Nucl. Soc., 9: 58-9(June 1966).

33804 COMPOSITION OF METALLIC INGOTS FORMED IN HIGH-PERFORMANCE CERAMIC FUEL ELEMENTS. Davies, J. H.; Boyle, R. F.; Weidenbaum, B.; Hanson, J. E. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 9: 63-4(June 1966).

33805 SHORT-TERM DYNAMIC EFFECTS UPON THE UTILIZATION OF PLUTONIUM AS A REACTOR FUEL. Sheff, James R. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 283-4(June 1966).

33806 A STUDY OF THE ZIRCALOY-STEAM REACTION. Kubit, C. J.; Stanutz, R. N.; Fultonberg, D. N.; Hazelton, W. S. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 299-300(June 1966).

33807 A PHOTOGRAPHIC STUDY OF THE TRANSIENT MELTDOWN BEHAVIOR OF ALUMINUM–URANIUM FUEL PLATES IN WATER. Harrison, L. J. (Argonne National Lab., Idaho Falls, Idaho); Ivins, R. O. Trans. Amer. Nucl. Soc., 9: 305(June 1966).

33808 DISPERSAL AND PRESSURE GENERATION BY WATER IMPACT UPON MOLTEN ALUMINUM. Wright, R. W.; Humberstone, G. H. (TRW Systems, Redondo Beach, Calif.). Trans. Amer. Nucl. Soc., 9: 305-6(June 1966).

33809 COATINGS OF HIGH-TEMPERATURE MATERIALS. Hausner, Henry H. (ed.). New York, Plenum Press, 1966. 303p. $15.00.

The problems of coating high-temperature materials and the progress made in the solution of these problems in the United States and USSR are considered. The book is divided into three parts: various types of coatings; materials to be protected by coating; application of coated materials in space technology; and fabrication and structure of coated materials. (D.H.M.)

33810 CERAMIC AND GRAPHITE FIBERS AND WHISKERS. A SURVEY OF THE TECHNOLOGY. McCreight, L. R.; Rauch, H. W. Sr.; Sutton, W. H. Refractory Materials. A Series of Monographs. Volume 1. New York, Academic Press, 1965. 407p. $10.00.

A survey of the state-of-the-art of whisker and fiber technology is presented. The main subjects discussed are: the theoretical strength of materials; the classification and applications of fibers; and the factors affecting fiber strength. The information presented is supplemented by a 550-entry bibliography, patent abstracts, and over 60 contact reports based on visits to both domestic and foreign organizations currently working with filamentary materials. (D.H.M.)

33811 METHOD OF PRODUCING URANIUM CARBIDE. Kasberg, Alvin H. (to Nuclear Materials and Equipment Corp.). U. S. Patent 3,250,588. May 10, 1966. Filed Apr. 2, 1963.

A two-step process for the production of high-density UC includes reacting the mixture of uranium oxide and carbon in a furnace under conditions of vigorous pumping to remove continuously the gases formed and then reacting the substantially gas-free porous material, predominantly UC, a nonconsumable-electrode arc. The product of the first reaction is broken up and continuously fed into the arc where it is converted to the compact solid with the emission of very little gas. The region of the arc is pumped to remove this residual gas that is released. A hydrocarbon binder is conveniently mixed with the starting mixture of uranium oxide and carbon. (B.L.M.)

Corrosion

33812 (BM-RI-6800) HIGH-TEMPERATURE CORROSION STUDIES. INFLUENCE OF YTTRIUM ON OXIDATION OF NICKEL AT 1200 DEG C. Doerr, Robert M.; Jensen, J. W.; Myers, Charles C. (Bureau of Mines, Rolla, Mo. Rolla Metallurgy Research Center). Sept. 1965. 23p. Bureau of Mines Free.

The oxidation kinetics of Ni-Y alloys in the range 0.04 to 8 wt % Y, and of high-purity Ni, were compared. The reactions followed approximately the parabolic rate law; for oxidations in O_2 at 0.5 atm and 1,200°C, the parabolic rate constant was about $0.37 + (0.064)\ (Y-2.11)$ mg cm^{-2} $min^{-\frac{1}{2}}$, where Y represents the wt % Y in the alloy. Internal oxidation of Y occurred in the alloy specimens and the resultant Y_2O_3 particles, which were in patterns related to the eutectic structure of the alloys, served as markers showing that the subsequent oxidation of the surrounding Ni was by inward diffusion of O. Outward diffusion of Ni and inward movement of O, from the inner boundary of the Y_2O_3-free part of the scale, are proposed as a mechanism for these results. (auth)

33813 (CEA-Bib-70) COMPRESSION DES POUDRES. (Pressing of Powders). Vergnon, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1966. 22p. Dep. mn.

A review is presented of equations proposed to relate the pressure applied on a powder to its resulting volume. These equations were tested with the data obtained by pressing spherical particles of alumina (less than a micron in dia.). The equation proposed by KAWAKITA is the only one which correctly fits the experimental results. The empirical equation of KAWAKITA is obtained theoretically by simple considerations. A physical meaning is proposed for several parameters of this equation; it allows an interpretation of the results. (auth)

33814 (COO-1319-40) CIRCULATING AUTOCLAVE SYSTEM FOR STRESS-CORROSION CRACKING STUDIES. Staehle, R. W. (Ohio State Univ. Research Foundation, Columbus). May 1966. Contract AT(11-1)-1319. 37p. (CONF-660607-2). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From 3rd International Symposium on the Effects of Irradiation on Structural Metals, Atlantic City.

A circulating autoclave system was constructed and operated in which time to breaking can be determined exactly at temperatures to 700°F, pressures to 5000 psi, a wide range of stresses, various dissolved gas and ionic specie concentrations, and for a large number of specimens exposed simultaneously. Preliminary experiments studied

commercial and specially melted iron–nickel–chromium alloys. Results confirmed already established trends of environment and alloy influences at 500°F. (auth)

33815 (EURAEC–1625) STUDIES OF STEEL CORROSION IN HIGH-TEMPERATURE WATER AND STEAM. Quarterly Report No. 14. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). Apr. 29, 1966. Contract 087-66-1TEEB(RD). 137p. (EUR–2838). Dep. mn. CFSTI $4.00 cy, $1.00 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Surface work-hardening effects on the oxidation of Cr and Cr–Ni steels in steam above 400°C were studied to define their recrystallization conditions. It was shown that mass work-hardening, produced by drawing of up to 15%, does not alter the corrosion behavior of 304 steel in steam at 500°C. Results of long-duration tests at 500°C by the hydrogen diffusion method confirm the need for a certain depth of work-hardening to guarantee good long-term behavior. The growth mechanism of the oxide layers on the nonsurface-work-hardened states of the same steels treated in superheated steam was examined to clarify the initial growth conditions of these layers. The epitaxial character of the outer magnetite layer still required explanation. An examination of oxide skins corresponding to residences of about 2 hours in steam at 500 and 450°C revealed the formation of a finely crystallized continuous skin (the size of the crystals was about 500 Å), on which the magnetite crystals of the outer layer seem to form. Corrosion of stainless steels in pressurized water was further investigated to clarify the mechanisms responsible for the maximum corrosion point at 200 to 250°C. It was shown that the oxidation mechanism takes the form of reciprocal migration. The decomposition of ferrous hydroxide, formed by diffusion of iron ions, into insoluble magnetite, leads to the formation of coarse magnetite crystals which grow epitaxially. Magnetite crystallization from the solution is liable to cause mass transfers from one grade of steel to another, and from the coldest to the hottest parts of the system. The maximum observed as a function of the experimental temperature is due qualitatively to the combination of the two kinetics of ferrous hydroxide production, on the one hand, and its decomposition into magnetite on the other. Surface treatment effects on the corrosion of Zircaloy 2 in pressurized water and superheated steam was examined. Surface treatment does not appear to affect the oxidation resistance of this alloy. On the other hand, a harmful influence of surface work-hardening is observed on the hydridization rate. Electrolytic polishing is generally favorable as regards both the hydridization rate and the distribution of the hydrides. (J.R.D.)

33816 (GEMP–414) THE PHYSICAL METALLURGY AND OXIDATION BEHAVIOR OF Fe–Cr–Al–Y ALLOYS. Wukusick, C. S. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). June 1, 1966. Contract AT(40-1)-2847. 22p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Studies were conducted of ferritic alloys of lower Cr and lower Y contents to relate their chemical composition to oxidation behavior, microstructure, and mechanical properties. Low temperature embrittlement was reduced by lowering the Cr content, but with concurrent increases in Al content to maintain oxidation resistance. The optimum composition for low temperature stability is Fe–5Cr–6Al–1Y. The most effective means of improving strength and ductility is the use of atomized powder containing finely dispersed YFe_9 particles. Oxidation tests in air at temperatures to 1100°C for 10,000 hours show that Y contents as low as 0.35% are effective in maintaining excellent oxidation resistance with a wide variety in Cr and Al contents. Resistance to steam corrosion decreases as Cr content is lowered. However, pre-oxidation of low Cr alloys in air provides suitable corrosion resistance in steam and good low temperature ductility. (auth)

33817 (MSAR–66–119) EFFECT OF HIGH TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS, Mechanical Properties of Materials. Topical Report No. 6, Effect of Carburization on the Phases in Austenitic Stainless Steel. Hiltz, Ralph H. (MSA Research Corp., Evans City, Pa.). June 1966. Contract AT(11-1)-765. 17p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A set of experiments were run on Type 304 and Type 316 stainless steels in high-carbon sodium to establish the role of stress in the phase transformations and the effect of time on the morphology of heavily carburized specimens. Thin tabs were used to minimize the carbon gradient through the specimen and thereby avoid volume effects. It was found that deterioration of Type 304 due to phase changes occurring during carburization does not cease when the carbon source is removed. Transformation to ferrite and carbide coalescence can persist for a measurable time after the source of contamination disappears. Three stress levels were investigated: 8,000, 10,000, and 12,000 psi. It was concluded that stress is not a requisite for ferrite formation but, above a certain level, it increases the amount of ferrite formed per unit time and per unit carbon. Type 316 tended to form ferrite at austenitic grain boundaries and to form course carbides within the ferrite phase. The 304 behaves in a similar manner except that the changes are greater in scope. (M.C.G.)

33818 (N–66–12875) HIGH TEMPERATURE PROTECTIVE COATINGS FOR REFRACTORY METALS. Progress Report No. 3, May 1–July 31, 1965. Criscione, J. M.; Rexer, J.; Fenish, R. G. (Union Carbide Corp., Parma, Ohio. Carbon Products Div.). Contract NASw-1030. 22p. (NASA-CR–68181). CFSTI $1.00 cy, $0.50 mn.

The rate of interdiffusion of iridium and tantalum was determined as a function of temperature in the range 1200 to 1600°C. An apparent activation energy of 53.5 kcal/mole was obtained for the overall diffusion process. Iridium-coated tantalum specimens were subjected to oxidation tests in slow moving air at 1850°C. Pressure bonded and electrodeposited coatings of iridium on tantalum were subjected to oxidation tests in slow moving air and in an oxygen-methane flame. A 5-mil iridium coat completely protected tantalum from oxidation for 51 hours at 1850°C in slow moving air. The recession rate of the coating was 0.02 mil/hr. No internal oxidation was observed. A 5-mil iridium coat on tantalum was also cycled four times without failure through various temperature spans in the range 25° to 1700°C in an oxygen-methane flame. Preliminary oxidation tests in slow moving air and in an oxygen–methane flame showed early failure for electrodeposited iridium coats on molybdenum, tantalum, and tungsten. Premature failure was due to poor adherence of the coating. (STAR)

33819 (ORNL-TM–1507) EVALUATION OF ALUMINUM FUEL ELEMENT CORROSION SAMPLE FROM PAKISTAN RESEARCH REACTOR. Kegley, T. M, Jr. (Oak Ridge National Lab., Tenn.). June 1966. Contract W-7405-eng-26. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

An aluminum fuel element corrosion sample from the Pakistan Research Reactor was received for evaluation. The comparatively thick white oxide corrosion product on the surface was identified by x-ray diffraction as predominantly bayerite, β-$Al_2O_3 \cdot 3H_2O$, which is the aluminum corrosion product formed below 90°C. The thickness of the corrosion product was 23.5 μ as determined metallographically and 16 μ as determined by cathodic defilming. Metallographic examination revealed three layers within the corrosion product, an inner adherent layer about 2.5-μ thick, an intermediate thicker layer 17-μ thick, and an outer serrated layer which averaged 4 μ in thickness. Cathodic defilming technique indicated a corrosion product film weight of 4.1 mg /cm^2 and a metal consumption of 5 μ (0.2 mil) of aluminum at the corroding surface. (auth)

33820 (TID–23122) THE INTERACTION OF OXYGEN WITH HOT TUNGSTEN. Singleton, J. H. (Westinghouse Research Labs., Pittsburgh, Pa.). May 5, 1966. Con-

tract AT(30-1)-2823. 30p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The reaction of oxygen at a polycrystalline tungsten surface was studied over a temperature range from 1300 to 2450°K and for oxygen pressures from ~10^{-6} to ~10^{-8} torr. A mass spectrometer was used to measure the oxygen pressure. In determining absolute pressures care was taken to avoid errors, which may arise due to spurious currents in a Bayard-Alpert ion gauge. The efficiency of removal of carbon impurity from tungsten, by heating in oxygen, was determined. After obtaining a low carbon content, the rates of removal of oxygen at the tungsten surface were determined as a function of temperature. At temperatures below ~2000°K evaporation of oxides of tungsten occurred at predictable rates. At higher temperatures atomic oxygen was produced and the observed rate of removal of oxygen is strongly influenced by the specific surfaces present in the entire system. For example, a silver surface efficiently reacts with oxygen atoms, without apparent saturation, to give a large apparent increase in the pumping speed at a tungsten surface enclosed in a glass system. (auth)

33821 PROBLEMS ARISING FROM THE CORROSION OF ORDINARY OR ALLOYED STEELS BY CARBON DIOXIDE AT HIGH TEMPERATURES. Darras, R.; Loriers, H. Bull. Inform. Sci. Tech. (Paris), No. 104, 85-91(May 1966). (In French).

The main problems presented by the corrosion by hot gases of ordinary or alloyed steels used as structural materials in French power reactors of the gas-graphite and gas-heavy water types are considered. All these reactors make use of pressurized carbon dioxide as the heat-carrying fluid. It is, however, in the case of gas heavy water type reactors that operating conditions are most severe: thus the slightly alloyed steels used for the external carbon dioxide circuits, as well as the stainless steel used as canning material for the first batch of fuel elements in the prototype reactor EL 4 will have to withstand temperatures approaching the maximum permissible limits. The research carried out by the CEA has aimed mainly at defining these limits, taking into account the secondary phenomena (stresses, friction, etc.) which could aggravate the corrosion. (auth)

33822 CORROSION OF STAINLESS STEELS AND REFRACTORY ALLOYS IN LIQUID SODIUM. Champeix, L.; Darras, R. Bull. Inform. Sci. Tech. (Paris), No. 104, 93-6(May 1966). (In French).

A study is made of corrosion problems arising from the use of certain materials in the presence of liquid sodium in fast reactors, account being taken of the corresponding particular conditions. For all practical purposes, austenitic stainless steels are satisfactory for a reactor such as Rapsodie. For a development of this reactor system it is quite feasible to consider using alloys richer in nickel. As for vanadium-based refractory alloys, much more practical testing is required before a decision can be reached concerning their possibilities. (auth)

33823 ATTACK OF PURE RHENIUM AND TUNGSTEN BY FUSED LANTHANUM AND CERIUM. Gaume-Mahn, Francoise; Ait-Yahia, Christine (Faculte des Sciences, Lyon). Compt. Rend., Ser. C, 262: 1528-9(May 23, 1966). (In French).

The corrosion of rhenium and tungsten by fused lanthanum and cerium was studied at temperatures between 800 and 1200°C for cerium and between 1000 and 1200°C for lanthanum. The fused rare earths were placed in scoops of rhenium and tungsten and maintained at a constant temperature for one hour. After cooling, the rhenium and tungsten were determined by spectrophotometry of their thiocyanide complexes. The results showed that no overflowing took place with the scoops used. The cerium was more reactive than lanthanum. Pure rhenium was perceptibly corroded at 1200°C. Pure tungsten was much less corroded at the higher temperature up to at least 1200°C. (J.S.R.)

33824 EFFECT OF HEAT TREATMENT ON THE CORROSION OF Zr–1Nb AND Zr–0.5Nb ALLOYS IN HIGH-TEMPERATURE STEAM. Rauschenbach, R. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 9: 124-7(Apr. 1966). (In German).

The corrosion of the Zr-base alloys Zr–1 Nb and Zr–0.5 Nb in steam at 400°C and 120 atm was investigated as a function of annealing temperature for various hold-up times. The Zr–1 Nb, annealed to recrystallization and then deformed, showed optimal corrosion behavior after annealing at 580°C. No effect of the various hold-up times on the corrosion resistance of the sample was observed. The corrosion of Zr–0.5 Nb did not change after annealing at 580 or 700°C. The results probably show that the alloy still remains in the range of maximal solubility at this temperature. (auth)

33825 COATED REFRACTORY METALS BEAT HEAT AND OXIDATION. Dormer, George. Mater. Design Eng., 64: No. 1, 83-7(July 1966).

Protective coatings and treatments available and their advantages and disadvantages are described. The types of coatings are discussed and compared. Coatings for molybdenum, niobium, and tantalum are tabulated. Tungstens coatings are considered in detail. (D.H.M.)

33826 MASS TRANSFER OF TANTALUM IN MOLTEN PLUTONIUM–COBALT–CERIUM FUELS—THE LINEAR MASS-TRANSFER EXPERIMENT. Biery, J. C.; Cushing, C. R. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 6-7(June 1966).

33827 CORROSION AND HYDRIDING OF ZIRCALOY UNDER HEAT-TRANSFER CONDITIONS IN PRESSURIZED WATER. Johnson, C. R. (Babcock and Wilcox Co., Lynchburg, Va.); Koch, D. W.; Campbell, T. M. Trans. Amer. Nucl. Soc., 9: 31-2(June 1966).

33828 HYDRIDE ORIENTATION AND CRYSTALLOGRAPHIC TEXTURE OF ZIRCALOY TUBING. Aqua, Edward N. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 33(June 1966).

33829 GENERAL CORROSION OF INCONEL-625 IN SIMULATED SUPERHEAT REACTOR ENVIRONMENT. Pearl, W. L.; Brush, E. G.; Gaul, G. G. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 9: 34-5(June 1966).

33830 CORROSION-RATE LOW CONSIDERATIONS OF INCONEL-625 EXPOSED TO SUPERHEATED STEAM. Brush, E. G. (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 9: 35-6(June 1966).

33831 CORROSION OF ELECTROLESS NICKEL-COATED 6061 ALUMINUM. Zukor, M.; Gibson, G. W. (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 9: 36(June 1966).

33832 USE OF ZIRCONIUM ALLOYS IN ORGANIC COOLANTS. Boulton, J.; Hatcher, S. R.; Hollies, R. E. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Trans. Amer. Nucl. Soc., 9: 45-6(June 1966).

33833 CORROSION MODEL FOR CORRELATING SIMULTANEOUS WEIGHT LOSSES AND GAINS IN LIQUID-METAL SYSTEMS. Mottley, J. C. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 59(June 1966).

33834 MERCURY CORROSION AND INHIBITION IN ONCE-THROUGH CROLOY 2¼-1 MOLYBDENUM STEEL BOILERS. Fleitman, A. H.; Romano, A.; Klamut, C. J. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 60-1(June 1966).

33835 ULTRASONIC-INDUCED CAVITATION STUDIES IN LIQUID METALS AT ELEVATED TEMPERATURES. Garcia, R.; Hammitt, F. G. (Univ. of Michigan, Ann Arbor). Trans. Amer. Nucl. Soc., 9: 61(June 1966).

Fabrication

Refer also to abstracts 33939 and 35110.

33836 (CEA-R-2911) CONTRIBUTION A L'ETUDE DU FRITTAGE DE L'ALUMINE FINEMENT DIVISEE. (Contribution to the Study of the Sintering of Finely Divided Alumina). Vergnon, Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 79p. Dep. mn.

Thesis. Submitted to Lyon Univ. (France). Faculte des Sciences.

Two crystalline forms of alumina, δ and α, were used to prepare compacts. The shrinkage of these compacts was investigated at different temperatures. The samples of alumina are composed of nonporous, spherical particles, of a very high purity. Their mean diameter varies between 160 and 1200Å for the δ-alumina samples and between 400 and 1200Å for the α-alumina samples. The shrinkage of compacts, heated at a linearly increasing temperature (300°C/hr) was studied in a dilatometer, modified to be used as a retractometer. The kinetics of the isothermal shrinkage of compacts after their rapid introduction in the high-temperature zone of the furnace were followed with a photographic technique. It is shown that the heating rate influence the shrinkage of the compacts when they are heated at temperatures over 1000°C. The kinetics of the isothermal shrinkage, at temperature between 1000 and 1600°C were thoroughly studied. Values of the apparent activation energy for the different classes of compacts are given. An interpretation of the results is proposed. It takes into account two different but interdependent mechanisms of sintering: the disappearance of porosity as a result of vacancy diffusion and the grain growth as a result of boundary migration. (auth)

33837 (CONF-660308, pp 87-91) PLUTONIUM FUEL DEVELOPMENT FACILITIES AT BABCOCK AND WILCOX. Edlund, M. C. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.).

The Babcock and Wilcox Company's Nuclear Development Center in Lynchburg, Virginia, is designed primarily for the development and testing of fuel elements containing plutonium and uranium-233. The utilization of such fuels in power reactors is contingent upon the development of economical fabrication processes. The vibratory compaction process may offer a clear advantage over the better-known pelletizing processes if the sol-gel method of preparing oxide is successfully developed. This method would eliminate the blending, canning, densification, and decanning operations required by the oxide-blending method. Therefore, B and W's current effort in this area is directed toward the development of high-density mixed oxides (PuO_2 and UO_2) prepared by the sol-gel method. (auth)

33838 (IS-T-90) SOME SINTERING RATES OF YTTRIUM SESQUIOXIDE. Schieltz, Jon David (Ames Lab., Iowa State Univ. of Science and Tech.). May 1966. Contract W-7405-eng-82. 55p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

Thesis.

Sintering studies were conducted with powder compacts of yttrium sesquioxide in a vacuum over the range from 1210 to 1643°C. Quantitive observations were made by measuring the change in length between the fired and unfired samples. The time dependence of the shrinkage rate was not consistent with any particular model. The apparent activation energy for the shrinkage rate over the indicated temperature range was 23 kcal per mole. Assuming a temperature-dependent end point density, the entire sintering path is described by a reduced-variable sine function. (auth)

33839 (N-65-31950) STUDY OF GROWTH PARAMETERS FOR REFRACTORY CARBIDE SINGLE CRYSTALS. Quarterly Status Report No. 5, March 1-June 1, 1965. Bartlett, R. W.; Nelson, W. E.; Carr, E.; Halden, F. A. (Stanford Research Inst., Menlo Park, Calif.). July 6, 1965. Contract NASr-49(19). 34p. (NASA-CR-64323). CFSTI $2.00 cy, $0.50 mn.

The three electrode a-c arc melting furnace for melt growth of crystals was assembled and tested. Crystal growth experiments and solubility experiments for solution growth of TaC were performed. Thermodynamic and kinetic factors affecting the selection of systems for solution growth of TaC were analyzed. Excessive supersaturation causes uncontrolled nucleation and leads to rapid precipitation of many small crystals rather than growth of a few large crystals. When excess free tantalum and carbon are absent from the melt system and another TaC sample is used as the nutrient, chemical activities of carbon and tantalum in the solution in equilibrium with the nutrient are diminished. Solvents with low activity coefficients are required to compensate for low activities and keep the carbon and tantalum concentration at an adequate level. If the reactant concentrations are too low, solution diffusion will be too slow and crystal growth rates will be retarded. (STAR)

33840 (N-66-16471) STUDY OF GROWTH PARAMETERS FOR REFRACTORY CARBIDE SINGLE CRYSTALS. Quarterly Status Report No. 7, September 1-December 1, 1965. Bartlett, R. W.; Nelson, W. E. (Stanford Research Inst., Menlo Park, Calif.). Jan. 5, 1966. Contract NASr-49(19). 21p. (NASA-CR-69912). CFSTI $1.00 cy, $0.50 mn.

Results of crystal growth experiments utilizing two methods, the liquid metal solution growth of crystals and the a-c arc melting method for Verneuil crystal growth, are reported. The arc-Verneuil crystal growth experiments were directed primarily toward reducing carbon losses in the molten carbide by altering the gaseous environment. All of the boules grown in pure argon showed extensive carbon loss within the appearance of large quantities of Ta_2C and even in some cases tantalum metal. Photographs of typical argon-grown boules are shown, illustrating the structures observed. A number of experimental problems were encountered and operations were suspended to modify the power supply, the arc-Verneuil furnace was extensively redesigned. The solution growth experiments emphasized attempts to determine the tantalum solubility in several carbon-saturated liquid metals and crystal-pulling experiments using a cold probe or single crystal tantalum seed. In both cases, it was found that nucleation and growth of many small tantalum carbide crystals in the cool region of the melt cause a uniform dispersion of small tantalum carbide crystals and prevent both growth of a large single crystal and sampling of the liquid phase exclusive of solid tantalum carbide. (STAR)

33841 (NAA-SR-10624) USE OF ADDITIVES IN THE PREPARATION OF URANIUM CARBIDE. Hanson, L. A. (Atomics International, Canoga Park, Calif.). June 15, 1966. Contract AT(11-1)-Gen-8. 31p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The use of additives in the preparation of uranium carbide by carbothermic reduction of uranium oxides, U_3O_8 and UO_2, was investigated as a potential method for preparing dense UC without melting. A number of additives were tested in gram scale experiments. The results with nickel metal and uranium alloys with Al, Fe, Ni, and Si were most promising. These additives were beneficial in obtaining hypostoichiometric UC of high density (over 95% of theoretical) and low residual oxygen content (a few hundred ppM) by heating in vacuum at 1650 to 1750°C. When used in amounts of 0.2 to 2 wt %, the added materials were generally eliminated by vaporization during the preparation. This method might also be useful in preparing uranium carbide melt stock of low oxygen content. (auth)

33842 (NASA-TN-D-3511) COLD CONSOLIDATION OF METAL PLUS DISPERSOID BLENDS FOR EXAMINATION BY ELECTRON MICROSCOPY. Reinhardt, Gustav; Cremens, Walter S.; Weeton, John W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). July 1966. 35p. CFSTI $2.00 cy, $0.50 mn.

An investigation was undertaken to determine the feasibility of high-energy-rate compaction as a means

of consolidating powder blends used in the preparation of dispersion-strengthened alloys. The techniques produced samples of sufficient density (greater than 85% of theoretical density) to be examined with an electron microscope. An advantage of the methods studied is that consolidation was accomplished without application of high temperature, and thus agglomeration that might result through diffusion or chemical reaction may be avoided. A cartridge-actuated compaction press proved to be a practical laboratory apparatus that readily consolidated Ni-base blends. Particles as fine as 0.01 micron were discernible in the microstructures. This particle size is within the range considered desirable for dispersion strengthening. A W-base blend was also compacted with a slight modification of the cartridge-actuated compaction press. In a limited number of tests, the Dynapak and the direct-contact sheet explosive methods proved to be effective means of consolidating powder blends. (J.R.D.)

33843 (NLCO-946, pp 79-102) EFFECT OF PREFERRED ORIENTATION AND STRESS ON THE DIRECTIONAL PRECIPITATION OF HYDRIDES IN ZIRCALOY-2. Rittenhouse, P. L.; Picklesimer, M. L. (Oak Ridge National Lab., Tenn.).

Specimens of several lots of Zircaloy-2 plate of known preferred orientation were examined to determine the effect of preferred orientation on the directional precipitation of hydrides. The orientation of the hydrides in unstressed material seems to be more associated with fabrication direction than with preferred orientation. Three materials of considerably different textures showed approximately the same orientation of hydride. The orientations observed in the unstressed specimens, assuming that fabrication by rolling is a compressive stress state, were consistent with the orientation of hydrides precipitated after plastic deformation by bending. These hydrides were rotated toward the tension direction in areas subjected to tension, realigned perpendicular to the compression direction in compression areas, and retained their original orientation at the neutral axis. (M.O.W.)

33844 (NLCO-946, pp 107-17) MEASUREMENT OF ORIENTATION IN EXTRUDED BeO. Sjodahl, L. H.; Bartram, S. F. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation).

Rods extruded from BeO powder calcined from beryllium sulfate contain grains oriented with their crystallographic c-axes lying in or near the extrusion direction. Extruded rods prepared from BeO powder calcined from $Be(OH)_2$ do not show this orientation, nor do isostatically pressed rods of either type. The degree of orientation is measured qualitatively and quantitatively by x-ray diffraction. (auth)

33845 (ORNL-P-2203) TUNGSTEN AND TUNGSTEN ALLOY TUBING DEVELOPMENT MEETING. A Summary of Progress. Harms, W. O. (comp.) (Oak Ridge National Lab., Tenn.). May 26, 1966. Contract W-7405-eng-26. 50p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Extrusion and drawing of tungsten and tungsten alloys is discussed. The direct production of the components by thermochemical deposition of the metal or alloy is also considered. The products were evaluated at various stages of development by metallography, x-ray-diffraction and chemical analyses, mechanical property determinations, joining studies, and some nondestructive testing techniques. The effects of warm rolling and heat treatment on the texture, microstructure, and ductility of tungsten sheet were studied. The physical metallurgy of thermochemically deposited tungsten sheet was investigated along with its creep-rupture properties. (M.C.G.)

33846 (ORNL-TM-1109(Rev.)) A STUDY OF SOL-GEL FUEL PREPARATION COSTS FOR SSCR AND HTGR REACTORS. Chandler, J. M.; Harrington, F. E. (Oak Ridge National Lab., Tenn.). May 13, 1966. Contract W-7405-eng-26. 34p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Both capital and operating costs were estimated for preparation, by the sol-gel process, of uranium–thorium materials for the Spectral Shift Control Reactor (SSCR) and High Temperature Gas-Cooled Reactor (HTGR). Annual capacities of 15, 60, 240, and 960 metric tons of heavy metal and flowsheets for no recycle, uranium-only recycle, and uranium–thorium recycle were studied. At 22%/year capital charges, the range of estimated costs was from 2.16 to 50.71 $/kg. (auth)

33847 (WAPD-TM-582) REMOVAL OF IRON AND BORON DURING FABRICATION OF CERAMIC FUEL PELLETS. Crain, H. H. Jr. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1966. Contract AT(11-1)-Gen-14. 18p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

An investigation was conducted on the volatilization of Fe and B contaminants from UO_2–ZrO_2 fuel pellets during sintering. Approximately 800 0.240-in. dia. pellets including high-density, thin-walled annular pellets, and low- and high-density solid pellets, were fabricated by the press-and-sinter method at various conditions. Two compositions, 28 wt.% UO_2–ZrO_2 and 36 wt.% UO_2–ZrO_2 were studied. B contamination, introduced as B_4C during comminution of the powder, is readily reduced from levels of 10 to 20 ppm to less than 0.5 ppm, even at sintering temperatures as low as 1350°C for 12 hr. Fe contamination, also introduced during powder comminution, is reduced from 2000 to 3000 ppm in the powder to a level of 300 to 500 ppm in solid pellets and less than 300 ppm in thin-walled annular pellets by 1700 to 1750°C sintering temperatures. (auth)

33848 (Y-1538) NICKEL COATING OF CERAMIC SPHEROIDS USING FINE NICKEL POWDER AND OXIDE. Lambdin, F. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 6, 1966. Contract W-7405-eng-26. 32p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The phenomenon of the natural adhesion of a fine powder to a larger body was applied to a method of coating ceramic spheres with a protective nickel coat. Coatings were applied and evaluated using the following powders: air-dried, high-surface-area nickel oxide screened to −325 mesh; nickel powder produced by the hydrogen reduction of air-dried, high-surface-area nickel oxide; combinations using the first two powders in alternate coating steps; and vacuum-dried, high-surface-area nickel oxide. All coatings were subsequently hydrogen reduced and sintered in place on the spheres. The resulting coats showed that the air-dried oxide produced serious cracking while the metal powder gave extremely thin coats with no appreciable cracking. The vacuum-dried oxide (low bulk density) showed good adhesion and produced fairly uniform, dense coatings in the thickness range of one mil. The method using vacuum-dried nickel oxide could be applied to large-scale coating applications. (auth)

33849 EFFECT OF HEAT TREATMENT ON CORROSION RESISTANCE OF ZIRCONIUM ALLOYS. Lupakov, I. S.; Parfenov, B. G.; Gromova, A. I. At. Energ. (USSR), 20: 330-3(Apr. 1966). (In Russian).

The effects of heat treatment on the corrosion resistance of Zr allowed with 1.0 and 2.5% Nb were investigated. It was found that double annealing results in a higher corrosion resistance in comparison with other types of thermal treatment. The best corrosion resistance was obtained with Zr alloyed with 2.5% Nb. (G.O.Y.)

33850 THEOREMS FOR CALCULATION OF WEIGHT RATIOS TO PRODUCE MAXIMUM PACKING DENSITY OF POWDER MIXTURES. Lewis, H. D.; Goldman, A. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Amer. Ceram. Soc., 49: 323-7(June 21, 1966). (LA-DC-6795).

Two mixing theorems are proposed to provide methods for testing for possible greater packing density of powder mixtures compared with unmixed components, predicting which of several powders or binary combinations of these powders gives the highest density, and calculating the weight mixing ratio to give maximum packing density for particular combinations. Calculations are based on proper use of particle "size" data obtained from typical commer-

cial "size" measuring devices, proper definitions of mixing and the fraction of powder occurring in "size" intervals, and functional or nonfunctional description of the data. (auth)

33851 EXPERIMENTS OF ELECTRICAL DISCHARGE MACHINING OF SAP. Belisario, Giancarlo (Univ., Rome). Ric. Sci. Riv., 36: 224-31(Mar. 1966). (In Italian).

Electrical discharge machining of SAP was studied. The work materials were three types of SAP with different alumina contents (7, 10, and 14%, respectively). The tool materials were aluminum, copper, magnesium, and zinc. Roughing and finishing operations were investigated for each pair of work-tool materials. (auth)

33852 INJECTION CASTING OF 10 WT PERCENT PLUTONIUM–ALUMINUM ALLOY FUEL ELEMENTS. Miller, Gary E. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 9: 1-2(June 1966).

33853 RESISTANCE HOT PRESSING OF URANIUM MONOCARBIDE. Chalder, G. H.; Berthiaume, L. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 9: 18-19(June 1966).

33854 DEVELOPMENT OF A SOL-GEL PROCESS FOR THE PREPARATION OF DENSE-OXIDE FORMS OF PuO_2. Haire, R. G.; Lloyd, M. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 20(June 1966).

33855 EXTRUSION OF TUNGSTEN AND TUNGSTEN-ALLOY TUBING. McDonald, R. E.; Reimann, G. A.; Leitten, C. F. Jr. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 68(June 1966).

33856 COST OF FABRICATING FUEL ELEMENTS CONTAINING HIGH-EXPOSURE PLUTONIUM. Burnham, J. B.; Merker, L. G. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 296-7(June 1966).

33857 METHOD FOR THE PRODUCTION OF NUCLEAR FUEL ELEMENTS. Jeitner, Franz (to Siemens-Planiawerke AG fuer Kohlefabrikate). German Patent 1,215,826. May 5, 1966. Filed July 25, 1960.

Nuclear fuel elements are shaped and provided with a graphite shell free from fuel in one pass by means of an elastic container, which is filled with a shell of graphite and a fuel-graphite mixture in its center. The method comprises the steps of compressing the elastic container, of removing the container, and of recompacting the graphite shell so that it becomes gas-tight and wear resistant. (Gmelin Inst.)

Properties and Structure

See also CHEMISTRY — Inorganic and Physical Chemistry

PHYSICS — Solid State Physics

33858 (AD–634094) METALLURGICAL CHARACTERISTICS OF HIGH-STRENGTH STRUCTURAL MATERIALS. [Ninth Quarterly Report]. Goode, R. J.; Huber, R. W.; Howe, D. G.; Judy, R. W. Jr.; Puzak, P. P.; Lloyd, K. B.; Crooker, T. W.; Morey, R. E.; Lange, E. A.; Freed, C. N. (Naval Research Lab., Washington, D. C.). Nov. 1965. 100p. (NRL–6405). CFSTI $3.00 cy, $0.75 mn.

Results of research studies in high strength structural materials are presented. Information is included on fracture toughness of high strength steels, Ti alloys, and Al alloys. Fracture diagrams modified to include the latest information are presented for these materials; the effects of processing variables are reflected in the fracture diagram for steels by the addition of an optimum materials trend line for consumable-electrode-vacuum melting of these alloys. Results are presented for studies concerning the use of side-grooved plane-strain fracture mechanics specimens for valid determination of fracture toughness, heat-treatment effects on fracture toughness of Ti alloys, the effect of vacuum heat treatment on stress-corrosion-cracking sensitivity of Ti, and the screening of titanium Ti alloy plates for sensitivity to stress-corrosion-cracking. The effects of mean strain on low-cycle fatigue crack propagation in 5 Ni–Cr–Mo–V steel and 7079-T6 aluminum are presented. Also described is a newly-developed low-cycle fatigue crack propagation test employing fracture mechanics parameters. Results are given for D6AC steels studied in this new test. (auth)

33859 (AD–634128) THE MICROSTRAIN REGION IN HIGH-PURITY REFRACTORY METALS. First Quarterly Report, March 1, 1966–May 31, 1966. Prekel, H. L.; Lawley, A.; Meakin, J. D. (Franklin Inst. Research Labs., Philadelphia, Pa.). Contract Nonr-4434(00). 31p. (Q-B2195-1). CFSTI $2.00 cy, $0.50 mn.

Modifications to a conventional electron beam floating zone unit are described. The filament is hidden from the specimen and this results in increased stability of operation, longer filament life, and excellent uniformity of crystal diameter (0.130 in. ± 0.001 in.). Mo single crystals grown from vacuum arc-cast and hot-swaged stock contain inclusions, and the crystals exhibit a high grown-in dislocation density $\sim 6 \times 10^7$ cm^{-2}; 90% of these dislocations are associated with and are attributable to the inclusions. Variations in zoning speed, number of zone passes, and annealing treatments at 1700°C in vacuum or in Ar have no appreciable effect on the number of inclusions. The inclusions are effectively removed from zoned crystals by annealing in H_2 at ~2000°C; this is accompanied by a decrease in dislocation density to $\sim 10^6$ cm^{-2}. H_2 annealing of the as-received material followed by zone melting gives inclusion-free crystals, and a dislocation density $\sim 4.5 \times 10^6$ cm^{-2}; a further H_2 anneal after zone melting reduced the density to $\leq 2 \times 10^5$ cm^{-2}. The observation that crystals grown from H_2-annealed stock are inclusion-free provides proof that there is no significant re-contamination of the Mo during zone melting. Preliminary dislocation velocity experiments are described. For this purpose, H_2-annealed and zone-melted crystals were tested in three-point bending. The basic relations in mechanical hysteresis were reexamined. (auth)

33860 (AD–634361) CHEMICAL STRENGTHENING OF CERAMIC MATERIALS. Summary Report. Kirchner, Henry P.; Gruver, Robert M.; Walker, Ralph E. (Linde Labs., Inc., State College, Pa.). May 7, 1966. Contract NOw-65-0407-c. 135p. CFSTI $4.00 cy, $1.00 mn.

An investigation of the effect of compressive surface layers on the strength of polycrystalline ceramic bodies is described. Low expansion surface layers were formed on polycrystalline ceramics by chemical reactions at high temperatures. During cooling after sintering, the main body tends to contract more than the surface layers leading to compressive stresses in the surfaces. Failure, by shearing of the surface layers, was prevented by establishing gradual variations in composition within the body. These variations in composition result in variations in expansion coefficient which, in turn, result in gradual variations in stresses and reduction of the maximum shear stress in the surface layer. The compressive stresses may act to reduce the contribution of surface flaws to the structural failure of these bodies. Chemical strengthening was attempted with alumina, titania, spinel, magnesia, forsterite, steatite, nickel oxide and zirconia bodies and was achieved for the first six materials named. The experiments with nickel oxide and zirconia gave unreliable results. In several of the successful cases the chemical treatments can be applied in either the fired or the unfired condition. The strength increases ranged up to about 37% when compared with the as received controls and up to about 97% when compared with fired controls that lost strength when refired with the treated samples. Chemical polishing, used to reduce the concentration of surface flaws, decreased the strength in most cases. The thermal expansion properties of a wide variety of solid solution compositions were measured. Some of these materials

have lower expansion coefficients than the bodies on which they would be placed. (auth)

33861 (BAW–237) STEAM COOLED BREEDER REACTOR. MECHANICAL AND PHYSICAL PROPERTIES OF SELECTED HIGH-TEMPERATURE MATERIALS. Lowe, A. L. Jr. (Babcock and Wilcox Co., Lynchburg, Va.). July 1965. 50p.

A description and enumeration is presented of mechanical properties of seven alloys which are being considered for use as fuel cladding in the Steam Cooled Breeder Reactor (SCBR). The alloys are types 304 and 348 stainless steels, 19-9 DL Alloy, Hastelloy-X-280, Incoloy alloy-800, Inconel alloy-625, and IN-102 Alloy. The properties most important to the selection of cladding material in the SCBR are elevated-temperature, ultimate, yield, and stress-rupture strengths, in combination with low neutron-capture cross section. Since no one alloy meets all the requirements for the ideal cladding material, the alloys are described so that their properties can be compared; in this way, the alloy(s) having the best combination of properties for a particular design application can be selected. (auth)

33862 (BMI-1775) FABRICATION, CHARACTERIZATION, AND THERMAL-PROPERTY MEASUREMENTS OF ZrO_2-BASE FUELS. Deem, Herbert W. (Battelle Memorial Inst., Columbus, Ohio). June 7, 1966. Contract W-7405-eng-92. 89p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Thermophysical-property specimens were fabricated and characterized from ZrO_2-20, -32, -50, and -94 wt % UO_2; ZrO_2-6.7 wt % CaO-17.5 wt % UO_2; ZrO_2-5.9 wt % CaO-39 wt % UO_2; and ZrO_2-5.2 wt % CaO-58 wt % UO_2. Experimental thermal diffusivity, density, and specific heat data were obtained at 200 to 2000°C and were used in calculations of thermal conductivity. Data are tabulated, and microstructure photographs are included. (J.R.D.)

33863 (CNLM–6335) SOLUBILITY STUDIES IN ALKALI METALS. Cleary, R. E.; Schenck, G. F.; Blecherman, S. S. (Pratt and Whitney Aircraft, Middletown, Conn, Connecticut Advanced Nuclear Engineering Lab.). Apr. 21, 1965. Contract AT(30-1)-2789. 10p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The solubility of Nb in Li was studied from 760 to 1540°C and that of Nb in K from 760 to 1205°C. The solubilities of Zr in Li at 1370°C and of Ca in 22Na–78K alloy were also studied. Data are presented in graphs. (M.C.G.)

33864 (EURAEC–1615) WORK HARDENING AND RECOVERY PHENOMENA IN ZIRCONIUM. PART II. Desalvo, A.; Zignani, F. (Bologna Univ. (Italy). Istituto di Fisica). [1965]. Contract 026-64-3-TEE I (RD). 28p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The recovery of Zr of two different purities, 80% cold rolled at room temperature, was followed by electrical resistivity measurements at −196°C. In 99.5% Zr, recovery is characterized by an activation energy increasing linearly with recovered extra-resistivity between 1.00 and 1.85 ev and by an activation energy of 2.30 ± 0.15 ev which corresponds to recrystallization. In 99.95% Zr the first stage is lowered at ~325°C and is characterized by an activation energy of 1.70 ± 0.15 ev. On the other hand, the first recovery stage begins only above 100°C and is characterized by a constant activation energy of 1.35 ± 0.05 ev. This may be reasonably attributed to point defect annealing which probably occurs also in 99.5% Zr, but remains unresolved under the continuous background due to dislocation rearrangement. (auth)

33865 (EURAEC–1623) STUDY OF THE BASE METAL INTENDED FOR RESEARCH ON THE BRITTLE FRACTURE OF LARGE WELDED ASSEMBLIES. Quarterly Report No. 8, January 1, 1966–March 30, 1966. (Institut de Recherches de la Siderurgie, St. Germaine-Enlaye (France)). Apr. 1966. Contract 031-64-5-TEE F (RD). 9p. (EUR–2836). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Transformation curves for Ammo steel under isothermal conditions are presented. The samples were austenized for 30 min. at 875°C. Micrographs are included to illustrate transformations. Information on grain growth is presented graphically. (J.R.D.)

33866 (EURAEC–1649) PLOTTING OF TRANSFORMATION CURVES FOR CONTINUOUS COOLING OF WEL-MONIX STEEL. Study No. 961. Special Report No. 12, January 1–March 31, 1966. (Chantiers de l'Atlantique Saint-Nazaire (France)). Mar. 18, 1966. Contract 054-61-12-RDF. 19p. (EUR–2847). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The transformation curves of Wel-Monix steel were plotted after austenitization at 900 and 1100°C for 30 min. The expansion measurement curves and the micrographs show that raising the austenitization temperature results in the ferrite-pearlite zone shifting towards the right. It was found that a given cooling rate does not produce a large increase in hardness in the second case with samples cooled to ambient temperature. After 30 min. treatment at 1100°C, the grain is larger than after treatment at 900°C. (auth)

33867 (GEAP–4849) COMPARATIVE PERFORMANCE OF ZIRCALOY AND STAINLESS STEEL CLAD FUEL RODS OPERATED TO 10,000 MWD/T IN THE VBWR. Baroch, C. J.; Hoffmann, J. P.; Williamson, H. E.; Pashos, T. J. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Apr. 1966. Contract AT(04-3)-189. 225p. Dep. mn. CFSTI $6.00 cy, $2.00 mn.

Test assemblies of fuel rods clad with Zircaloy-2, Zircaloy-4 and type 304 stainless steel were irradiated in the VBWR to determine the comparative performance characteristics of each type of cladding under high specific powers and at high heat fluxes. These fuel rods were fabricated utilizing typical commercial fabrication processes. The fuel rods contained 95 percent-dense UO_2 pellets in self-supporting tubes. Irradiation test experiences and the results of post-irradiation examinations performed are presented. (auth)

33868 (IS–T–82) CRYSTAL STRUCTURES OF Na_2Tl AND Li_9Al_4 AND A BONDING MODEL FOR Na_2Tl. Hansen, David Arthur (Ames Lab., Iowa State Univ. of Science and Tech.). May 1966. Contract W-7405-eng-82. 94p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Thesis.

An investigation was conducted to determine whether heavy-atom configurations exist in Na_2Tl and Li_9Al_4 (previously reported in the literature as Li_2Al). Na_2Tl was found to crystallize in the unique space group $C222_1$ with 48 atoms per unit cell. The Tl atoms occupy two eightfold sets while the Na atoms occupy two fourfold sets and three eightfold sets. The unit cell dimensions were determined to be $a_0 = 13.9350 \pm 0.0004$ A, $b_0 = 8.8797 + 0.0003$ A and $c_0 = 11.6927$ A. The Na_2Tl structure determination revealed that the Tl atoms cluster together in the form of four-atom tetrahedra. These tetrahedra are nearly regular and are separated from each other by the Na sublattice such that there are no nearest-neighbor Tl-Tl interactions except those within a Tl tetrahedron. The interatomic distances indicate strong Tl-Tl binding within the Tl tetrahedra. Li_9Al_4 crystallizes in the space group B2/m with 26 atoms per unit cell. The Al atoms occupy two fourfold sets and the Li atoms occupy a twofold set and four fourfold sets. The unit cell dimensions were determined to be $a_0 = 19.1551 \pm 0.0005$ A, $b_0 = 5.4288 \pm 0.0001$ A, $c_0 = 4.4988 \pm 0.0001$ A and $\gamma_0 = 107.671^0 \pm 0.002^0$. The Li_9Al_4 lattice is layered and is closely related to the structure of $MoSi_2$. A valence rule for use in predicting the stoichiometry of compounds likely to contain tetrahedra was postulated. (J.R.D.)

33869 (LA–3410) DIFFERENCE EQUATIONS FOR HEATED, PLANE-STRAINED, INHOMOGENEOUS, MUL-

TIPLY CONNECTED ORTHOTROPIC MEDIA. Stein, Leland R. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). June 17, 1966. Contract W-7405-eng-36. 81p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

By using a square net with irregular triangles along boundaries, the difference equations, in terms of the displacement components, are derived by variational means for a heated, plane-strained, inhomogeneous, multiply-connected orthotropic medium. The physical interpretation of the difference equations in the interior and on the various boundaries of the medium is demonstrated. The matrix of the resulting linear system of equations, including the boundary terms, is positive semi-definite. This characteristic of the resulting matrix assures convergence of the solution by over-relaxation methods. A numerical solution was carried out using an infinite plane-strained, non-uniformly heated annulus. The outer surface was stress free and adiabatic. The inner surface was also stress free, but the temperature gradient there was proportional to the temperature at the inner surface. Comparison of the numerical solution with that of the analytic solution is made. (auth)

33870 (MIT-1002-1) THERMODYNAMIC AND OTHER ASPECTS OF METALLIC SYSTEMS. Annual Progress Report. Bever, M. B.; Robinson, P. M.; Leach, J. S. Ll.; Jena, A. K.; Chuang, K. C.; Gangulee, A.; Scattergood, R. O.; Waldman, J. (Massachusetts Inst. of Tech., Cambridge). June 1966. Contract AT(30-1)-1002. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Results of investigations are summarized concerning deformation of Ag–Mg solid-solution alloys containing 0 to 26 at.% Mg; deformation of Ag–Cd solid-solution alloys containing 0 to 39 at.% Cd; relations of short-range order with dislocation and deformation behavior of Cu–Al solid-solution alloys, annealing kinetics of intermetallic AgMg after deformation, order-disorder transformations in Ag-rich Ag–Mg alloys, and heats of formation of Ag-rich Ag–Mg and Ag–Cd solid-solution alloys. (J.R.D.)

33871 (N-65-30832) EVALUATION OF Be–38 Al ALLOY. Final Report, June 27, 1964–February 28, 1965. Fenn, Raymond W. Jr.; Coons, W. C.; Crooks, Donald D.; Neiman, Alfred S.; Robinson, John (Lockheed Missiles and Space Co., Palo Alto, Calif. Materials Sciences Lab.). Contract NAS8-11448. 108p. (NASA-CR-64343). CFSTI $4.00 cy, $0.75 mn.

Detailed studies were made on six heats of Be-38% Al alloy in the annealed temper to determine the level and reproducibility of mechanical properties, the microstructural features, preferred orientations, and the general metallurgical quality of the metal. Data reported include: Young's modulus, tensile, compressive, shear, bearing, and bend properties at temperatures from –320 to 800°F; tensile properties at 75°F after exposure to 400 or 800°F for 10, 100, and 1000 hr; representative photomicrographs; and pole figures [viz: Be (0002), Be ($10\bar{1}1$) and Al (111)]. Average longitudinal properties at 75°F for the material studied are presented. Mechanical property data are summarized in tables. (STAR)

33872 (N-65-31175) THE PREPARATION AND EVALUATION OF HIGH-PURITY FINE-GRAINED TUNGSTEN AND TUNGSTEN ALLOY CASTINGS. Summary Report. Nelson, S. G.; Foster, E. L. Jr. (Battelle Memorial Inst., Columbus, Ohio). July 9, 1965. Contract NAS3-6279. 34p. (NASA-CR-54374). CFSTI $2.00 cy, $0.50 mn.

A technique was developed for the preparation of high-purity, cylindrical castings of high-melting-point materials. Relatively fine-grained, $\frac{3}{4}$-in.-diameter, tungsten and W–Ta, W–Re, W–Ir, and W–Os alloy castings were prepared by this technique. Most castings contained less than 50 ppm total impurities as determined by mass-spectrographic, gas, and conductometric analyses. (STAR)

33873 (N-66-12349) ION ENGINE SUPPORTING RESEARCH AND EVALUATION. VOLUME II. IONIZATION STUDIES. Summary Report. Husmann, O. K. (Hughes Research Labs., Malibu, Calif.). Nov. 1965. Contract NAS3-4110. 106p. (NASA-CR-54411). CFSTI $4.00 cy, $0.75 mn.

Porous tungsten pellets were improved by using highly classified spherical tungsten powder. Neutral efflux as low as 2.7% at 10 mA/cm^2 was measured, with critical temperature only about 20°K above that of the solid metal. Hydrocarbons efficiently carburize the ionizer; therefore their partial pressure should be below 10^{-10} torr for the 1000 hour test. With carburization, the critical temperature increases; and in the case of W_2C and WC the neutral efflux increases due to the lowered work function. In the case of pyrolytic graphite deposits, the work function slightly exceeds that of tungsten. Cesium ion desorption energies, measured by the pulsed desorption technique, are in reasonable agreement with the theoretical interpretation, if the quantum-corrected image force and the ion polarizability are considered. These measurements are in good agreement with desorption energies computed from critical temperature data, if changes in surface coverage are considered. (auth)

33874 (N-66-16420) INFLUENCE OF BORON ADDITIONS ON PHYSICAL AND MECHANICAL PROPERTIES OF ARC-MELTED TUNGSTEN AND TUNGSTEN–1 PERCENT TANTALUM ALLOY. Raffo, Peter L.; Klopp, William D. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1966. 22p. (NASA-TN-D-3247). CFSTI $1.00 cy, $0.50 mn.

The effects of boron additions on the physical and mechanical properties of arc-melted tungsten and a tungsten-1 percent tantalum alloy were investigated. Boron additions significantly refined the as-melted grain size of tungsten. The 1-hour recrystallization temperature was initially increased by small boron additions (approx 0.01 atomic percent boron), after which it decreased continuously with increasing boron content. High-temperature tensile tests showed that the boron additions produced an initial rapid rise in strength followed by a leveling off of the strength-composition curve. Boron in solid solution was postulated to be the cause of the rapid increase in strength. (auth)

33875 (N-66-16551) MECHANICAL PROPERTIES OF SOLID-SOLUTION AND CARBIDE-STRENGTHENED ARC-MELTED TUNGSTEN ALLOYS. Raffo, Peter L.; Klopp, William D. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1966. 37p. (NASA-TN-D-3248). CFSTI $2.00 cy, $0.50 mn.

The mechanical properties of several arc-melted tungsten alloys containing rhenium, tantalum, columbium, hafnium and/or carbon were investigated in the temperature range 2500 to 4000°F. Solid-solution strengthening in tungsten alloys was most effective in tungsten–hafnium alloys and least effective in tungsten–rhenium alloys. Carbon additions to unalloyed tungsten produce a minimum in the tensile-strength carbon-content curve. Carbon additions to tungsten–columbium, tungsten–tantalum, tungsten–tantalum–rhenium, and tungsten–hafnium alloys produced various degrees of strengthening with the largest effect found in the tungsten–hafnium–carbon alloys. The differences in strength between the various carbide-strengthened alloys were a result of the differences in the carbide particle size, where the finest particle size was observed in the tungsten–hafnium–carbon alloys. The strongest alloy, tungsten–0.20 atom percent hafnium–0.26 atom percent carbon, had a tensile strength of 62,500 pounds per square inch at 3500°F in the as-swaged condition, and recrystallized only after annealing for 4 hours at 4200°F. (auth)

33876 (N-66-17087) GRAPHITE–METAL COMPOSITES. Quarterly Report No. 2. Harada, Y.; Rubin, G. A. (IIT Research Inst., Chicago, Ill.). Jan. 21, 1966. Contract NASr-65(09). 32p. (NASA-CR-70320; IITRI-G6003-2). CFSTI $2.00 cy, $0.50 mn.

Compositional studies were made to determine the ef-

fect of graphite source material on the properties of Mo–C composites. Investigations of other systems incorporating tungsten, vanadium, hafnium, tantalum, niobium, and zirconium as the metal constituent were also conducted. Studies of time-temperature relationships in processing were initiated, and measurements of electrical resistivity were made. It was concluded that the use of flat, platy particles as opposed to spherical cokes yields better bonding in graphite-metal composites. In the Nb–C system, room temperature flexural strengths of greater than 20,000 psi and an increase in strength at 2000°C can be expected for compositions in the eutectic range. Work with the zirconium system shows that room-temperature strengths in excess of 13,000 psi can be realized at 50 wt.% Zr. The processing temperature should not exceed the carbide–carbon eutectic temperature by more than about 50°C if significant loss of metal is to be avoided. (STAR)

33877 (NAA-SR- Memo–11788) THE EFFECT OF VARIATIONS IN CHEMICAL COMPOSITION ON THE CREEP-RUPTURE BEHAVIOR OF AUSTENITIC STAINLESS STEELS. Johnson, G. D. (Atomics International, Canoga Park, Calif.). Dec. 15, 1965. Contract AT-11-1-GEN-8. 35p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The ways in which variations in chemical composition may affect the creep-rupture behavior of austenitic stainless steels are reviewed. In general, these changes in chemistry produce second phases, such as carbides or sigma, and they, in turn, alter the high-temperature deformation processes. An investigation is being conducted to determine the effect in variations from heat-to-heat on the creep-rupture behavior of 304 and 316 stainless steel. (auth)

33878 (NLCO–946) PAPERS PRESENTED AT THE X-RAY PREFERRED ORIENTATION MEETING HELD AT NATIONAL LEAD COMPANY OF OHIO, DECEMBER 5 AND 6, 1963. Colby, John W. (ed.) (National Lead Co. of Ohio, Cincinnati). Dec. 15, 1965. Contract AT(30-1)-1156. 110p. (CONF-631205). Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Separate abstracts were prepared for 4 of the 6 included papers. The remaining papers appeared previously in NSA as 19: 892 and 20: 13983. (M.O.W.)

For abstracts of individual papers see: 33843, 33844, 33879, and 33880.

33879 (NLCO–946, pp 63-7) GENERAL FORM OF THE SECOND ORDER TENSOR FOR PREDICTING PHYSICAL PROPERTIES IN ORIENTED MATERIALS. Sturcken, E. F.; Croach, J. W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

A general method for inverting pole figures for materials having orthorhombic symmetry is described and is applied to uranium. (M.O.W.)

33880 (NLCO–946, pp 103-6) HEAT TREATMENT OF EXPERIMENTAL INGOT ALLOYS. Starbuck, J. W. (Mallinckrodt Chemical Works, [St. Louis, Mo.]).

Growth indexes are given for uranium metal having a wide variation in chemical content and having varying heat treatments. (M.O.W.)

33881 (NLCO–977) THE IDENTIFICATION OF INCLUSIONS IN URANIUM METAL BY COLOR METALLOGRAPHY. Schaich, E. L. (National Lead Co. of Ohio, Cincinnati). May 1, 1966. Contract AT(30-1)-1156. 9p. (CONF-660518–5). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From AEC Annual Metallography Meeting, Denver.

Techniques were developed to permit optical identification of various phases and inclusions in U metal by controlled oxidation or heat tinting. In this method the various phases are caused to assume characteristic colors by which they can be identified. Particles that can be distinguished at present include UC, U_6Fe, U_3Si, and UAl_2. Sample preparation, heat tinting procedures, and identification are discussed. (auth)

33882 (NLCO–978) A CONTRIBUTION TO THE STUDY OF URANIUM-BASE DILUTE ALUMINUM ALLOYS. Althaus, W. A.; Cook, M. M. (National Lead Co. of Ohio, Cincinnati). May 1, 1966. Contract AT (30-1)-1156. 13p. (CONF-660518–4). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From AEC Annual Metallography Meeting, Denver.

The isothermal annealing characteristics of the eutectoidal decomposition of U-base dilute Al alloys in the beta phase was studied by optical and electron microscopy. The effects of the Fe and C on this eutectoidal decomposition are described. (auth)

33883 (NYO–2471-19) INTERNAL FRICTION AND ELECTRON MICROSCOPY STUDIES IN MAGNESIUM–LITHIUM. Ueki, Mikio (Cornell Univ., Ithaca, N. Y. Materials Science Center). June 1966. Contract AT(30-1)-2471. 65p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Thesis.

The internal friction of oriented single crystals of Li-doped Mg was studied at 80 to 300°K at a frequency of 40 kc/sec. Attention was paid to the influence of small amounts of impurities on the internal friction spectrum in plastically deformed Mg crystals. Simultaneously, direct observations of the dislocation structures in these samples were obtained by transmission electron microscopy. Three peaks at about 140, 170, and 210°K were observed in the Mg–Li samples after plastic deformation. The peak heights increase monotonically as the amount of deformation increases but no decrease with heavier deformation was observed in contrast to the behavior of the peaks in pure Mg samples. The presence of substructures which were observed by electron microscopy in deformed pure Mg samples, but which are absent in Mg–Li samples, seems responsible for the difference between pure and Li-doped Mg in their character of the internal friction spectrum. Samples compressed along the basal plane displayed $\{10\bar{1}2\}$-type twinning. (auth)

33884 (SC-CR–66-2029) AEROSPACE NUCLEAR SAFETY INVESTIGATIONS OF REENTRY ABLATION PHENOMENA. Quarterly Report. Beal, J. L.; Brown, W. R.; Adams, D. E. (Cornell Aeronautical Lab., Inc., Buffalo, N. Y.). Jan. 1966. Contract AT(29-1)-789. 91p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

For Sandia Corp., Albuquerque, N. Mex.

Simulated reentry tests of zirconium hydride are interpreted and a method for predicting disintegration is suggested. Experimental observations of the removal of a continually formed liquid layer by aerodynamic forces on a cylinder are presented. Calculations show the decrease in size of liquid drops decelerating in free-molecular flow for three metals. Measurements of the maximum vaporization rate of certain solid magnesium alloys at temperatures near the melting point are presented. (auth)

33885 (SC-RR–66-290) SHOCK LOADING OF POROUS TUNGSTEN. Boade, R. R. (Sandia Corp., Albuquerque, N. Mex.). June 1966. Contract AT(29-1)-789. 22p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The effects of high-pressure shock loading in foamed W are examined to obtain Hugoniot equation-of-state data for this material. The density of the foam used was 3.70 g/cm^3. The results are compared with a plate model for porous materials and found to be compatible. Results are presented in both tabular and graphic form. (auth)

33886 (UCRL–14152) STRUCTURES OF THE RARE EARTH MONOGERMANIDES. Tharp, A. G.; Smith, Gordon S.; Johnson, Quintin (Lawrence Radiation Lab., Univ. of California, Livermore). June 20, 1965. Contract W-7405-eng-48. 15p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Single-crystal x-ray diffraction methods demonstrated the existence of the $CrB(B_f)$ structure type for the monogermanides of Nd, Sm, Eu, Gd, and Tb. Single crystals of preparations of similar composition but using Dy, Ho, Er, Tm, Yb, and Lu proved to have a large, body-centered tetragonal cell of unknown structure type. A careful study of powder patterns revealed dimorphous behavior for several of the monogermanides. Thus, DyGe, HoGe, and prob-

ably ErGe also have CrB-type modifications; the body-centered tetragonal form, believed to be a high-temperature modification, was also found for GdGe and TbGe. Lattice constants for the two series are given. In the LuGe system a rhombohedral phase, probably of the Cr_5Al_8 type, was also found. The FeB structure type recently reported for CeGe was confirmed. (auth)

33887 (UCRL-16770) DISLOCATION MECHANISMS IN AN IRON-MANGANESE ALLOY AT LOW TEMPERATURES. Wynblatt, Paul Pinhas (Lawrence Radiation Lab., Univ. of California, Berkeley). June 1966. Contract W-7405-eng-48. 35p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.
Thesis.

The effect of strain rate, temperature, and interstitial impurity concentration on flow stress was investigated in a polycrystalline iron-2% manganese alloy. The temperature dependence of the flow stress was found to be independent of the interstitial impurity concentration; removal of interstitials decreased the athermal stress level. Below 160°K, the large temperature dependence of the flow stress was interpreted in terms of the Dorn-Rajnak theory of the Peierls mechanism of plastic deformation. Above 160°K, some other thermally activated intrinsic mechanism seems to be operating. (auth)

33888 (UCRL-16782) SOME OF THE PHYSICAL PROPERTIES OF CURIUM AND PROTACTINIUM METALS AND PROTACTINIUM TETRAFLUORIDE. Bansal, Brij M. (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 15, 1966. Contract W-7405-eng-48. 149p. Dep. mn. CFSTI $4.00 cy, $1.00 mn.
Thesis.

The construction and operation of a semi-adiabatic microcalorimeter are discussed. The heat of solution of curium metal in 1.0M HCl at 298.4 ± 0.2°K was measured and found to be −139.9 ± 1.0 kcal/mole. This value was combined with available thermodynamic data to calculate the following standard heats of formation at 298°K: $Cm^{+3}_{(aq)}$, −140.6 ± 1.3; $CmCl_{3(c)}$, −226 ± 1.2, both in kcal/mole. The construction and operation of a low-temperature magnetic susceptibility apparatus are discussed in detail. The magnetic susceptibility of curium metal was investigated from room temperature to about liquid helium temperature (6 to 8°K). The metal followed the Curie-Weiss law from room temperature to 145°K. Between 145 and 77°K the metal became ferromagnetic with a Curie temperature T_c = 131 ± 10°K. At liquid hydrogen and helium temperatures the metal again seemed to show paramagnetic behavior. No evidence of antiferromagnetic behavior, however, was observed. The effective magnetic moment for the metal was found to be 8.03 ± 0.1 Bohr magnetons, indicating the presence of a $5f^1$ configuration in the metal. The magnetic susceptibility of protactinium metal was measured in the temperature range from 20 to 298°K. The molar susceptibility was found to be $268 \pm 14 \times 10^{-6}$ cgs units at room temperature, and to be virtually independent of temperature within the experimental accuracy of ±5% over the temperature region investigated. The molar magnetic susceptibility of PaF_4 was calculated from the available Landé g value for octahedrally coordinated Pa(IV) ($PaCl_4$-Cs_3ZrCl_6 crystal) and the J quantum number of Pa(IV) ground state; the value so calculated was 4735×10^{-6} cgs units. (auth)

33889 (UCRL-16846) CALCULATION AND MEASUREMENT OF THE YIELD STRESS OF ALLOYS WITH COHERENT LAMELLAR MICROSTRUCTURES. Dahlgren, Shelley Dean (Lawrence Radiation Lab., Univ. of California, Berkeley). May 1966. Contract W-7405-eng-48. 53p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.
Thesis.

Coherency strain fields in precipitation hardened alloys are usually non-uniform and difficult to analyze. Cu-Ni-Fe alloys, however, can be made to possess coherent lamellar microstructures which have small and uniform strains. Calculations of yield stresses based on these coherency strains agree with measured values. The yield stresses of the Cu-Ni-Fe alloys studied are independent of the interlamellar spacing and independent of the volume fractions of the two chemically different lamellae present; however, they are directly proportional to the differences in cubic lattice parameters of the two kinds of plates forming the lamellar structure. The lamellar microstructures are produced from supersaturated solid solutions by a demixing process. That is, atoms of one kind cluster to form one type of lamellae and the remaining atoms cluster to form the other type of lamellae which form during low temperature transformation. Because the average atom sizes are different in the two chemically different lamellae the lamellar plates must be strained in order for coherency to be maintained between the lamellae. This coherency is lost in overaging, and the compositions of the two lamellae are given by the positions of the phase boundary lines on the equilibrium diagram. However, when coherency is maintained the demixing process is stopped short of completion at low temperatures such that the compositions of the two lamellae are not given by the equilibrium diagram. (auth)

33890 NEUTRON DIFFRACTION INVESTIGATION OF WO_3. Loopstra, B. O.; Boldrini, P. (Reactor Centrum Nederland, Petten, Netherlands). Acta Crystallogr., 21: 158-62(July 10, 1966).

The structure of the room-temperature modification of stoichiometric WO_3 was determined by a neutron-diffraction powder investigation. The space group is $P2_1/n$ and the cell constants are a = 7.297, b = 7.539, c = 7.688 Å, β = 90.91°. W-O bonds form zigzag chains in three directions with W-O-W angles of 158 and O-W-O angles of 166°. In the *x* direction the bonds are of equal length, while in the y and z directions they are alternately long and short. (auth)

33891 STRESS RELAXATION AND THE DUCTILE-BRITTLE TRANSITION TEMPERATURE OF MOLYBDENUM. Sargent, G. A. (Mellon Inst., Pittsburgh); Shaw, B. J. Contract NONO4442(00). Acta Met., 14: 909-12 (Aug. 1966).

Stress relaxation was used to study plastic deformation prior to yielding or fracture in molybdenum specimens, which were tested both above and below the ductile-brittle transition temperature. It was found that some dislocations were mobile prior to brittle fracture, lending support to the ideas expressed by Cottrell and Stroh, that dislocation interactions may be responsible for the initiation of fracture. (auth)

33892 TWINNING, SLIP, AND CATASTROPHIC FLOW IN NIOBIUM. Reid, C. N.; Gilbert, A.; Hahn, G. T. (Battelle Memorial Inst., Columbus, Ohio). Contract AF33-(657)-7376. Acta Met., 14: 975-83(Aug. 1966).

Mechanical tests were carried out in tension and compression on single and polycrystalline niobium. The orientation dependence of the mechanical properties at 77°K was studied, and the behavior was found to be highly anisotropic. Crystals with axes near [011] deformed by profuse twinning in compression, while under tensile loading these crystals yielded by slip at much higher stresses. Similar behavior was observed at 78°K in polycrystalline niobium containing a strong [011] recrystallization texture. Crystals oriented near $[\bar{1}11]$ underwent catastrophic, localized flow when tested in tension; the plane of shear was found to be near (011) and the shear direction near $[\bar{1}00]$. It is deduced that this behavior was caused by the motion of dislocations with an $a[\bar{1}00]$ Burgers vector, and is a consequence of the elastic properties of niobium. Crystals with axes near [001] deformed entirely by slip. Observations of slip lines on crystals are described, and it appears that both {110} and {112} are preferred slip planes in niobium at 80°K. There is evidence that slip on {112} planes in the sense of the direction appropriate for twin formation occurs at lower stresses than slip in the opposite sense. (auth)

33893 INTERNAL FRICTION OF COLD-WORKED NIOBIUM AND TANTALUM CONTAINING OXYGEN AND NITROGEN. Van Ooijen, D. J.; Van Der Goot, A. S. (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Acta Met., 14: 1008-9(Aug. 1966).

Measurements are presented on the Snoek peak (SP) and the cold-work peak (CWP), which are caused in niobium

and tantalum by oxygen and nitrogen. An oxygen–nitrogen substitution mechanism at the dislocation was confirmed for both Nb and Ta. The internal friction was measured on a laboratory scale as a function of temperature. With increasing temperature the nitrogen SP increased while the oxygen SP decreased. Differences in variations with temperature are explained by the fact that N atoms are substituted for the O atoms at the dislocations. This explains the disappearance of the oxygen CWP and simultaneous recovery of the oxygen SP, and the appearance of nitrogen CWP at 500°C and the simultaneous decrease of the nitrogen SP. No further changes were noted on a second run of the temperature up to 700° and back to 20°C. (P.C.S.)

33894 ANALYSIS OF RELAXATION TESTS ON SPECIMENS WITH INHOMOGENEOUS STRESSES. Lewthwaite, G. W.; Mosedale, D. (Dounreay Experimental Reactor Establishment, Dounreay, Eng.). Brit. J. Appl. Phys., 17: 821-5(June 1966).

The behavior of beams and torsion specimens when used in stress-relaxation experiments is analyzed for some ideal solids with simple creep laws. It is shown how the experimentally observable deformations can be forecast and the difficulties in the reverse process, deriving a creep law from the experimental observations, are made obvious. Possible errors in the analysis of some irradiation creep tests are discussed, and it is shown that to one set of experimental data at least two models can be fitted equally satisfactorily. (auth)

33895 STEELS IN THE NUCLEAR INDUSTRY. Andre, J.-P.; Dabosi, F.; Le Bret, P. Bull. Inform. Sci. Tech. (Paris), No. 104, 65-83(May 1966). (In French).

Steels have many fields of application in the nuclear industry. These fields were classified into two main groups: pressure vessels and structural elements and cans for fuel elements. Inside each category are presented the problems arising and the materials used. The problems, essentially mechanical, vary according to the category: For the pressure vessels and the structural elements the problems concern behavior under pressure, rigidity, breakage risks (due to fatigue or to inherent weaknesses). For the cans, the main problem is the resistance to creep when hot. Since the selection criteria vary, the materials used are generally different in each case. In the first category, use is made of ferritic steels, very high strength steels, and sometimes austenitic steels. In the second category, austenitic steels are used (or refractory alloys). (auth)

33896 CRYSTALLINE STRUCTURES OF INTERMETALLIC COMPOUNDS T_2Co_{17} IN WHICH T IS A METAL OF THE RARE EARTHS OR YTTRIUM. Bouchet, Gerard; Laforest, Jean; Lemaire, Remy; Schweizer, Jacques (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). Compt. Rend., Ser. B, 262: 1227-30(May 2, 1966). (In French).

The two crystalline forms, rhombohedral and hexagonal, of T_2Co_{17} alloys are described and discussed as a function of thermal treatment and of the rare earth elements. (tr-auth)

33897 DISPLACEMENT OF ZIRCONIUM ^{95}Zr DURING ZONE FUSION OF ALUMINUM. Kuchar, Lumir (Centre d'Etudes de Chimie Metallurgique, Vitry, France). Compt. Rend., Ser. C, 262: 1466-9(May 16, 1966). (In French).

The diffusion of ^{95}Zr in aluminum treated by zone fusion in graphite cells was studied. The effective partition coefficient was determined as $k_{eff} = 1.4 \pm 0.2$ for velocities of 4 cm/hr and $k_{eff} = 1.2 \pm 0.1$ for 6 cm/hr. These values were compared with the theoretical partition coefficient $k_0 = 2.5$ calculated from the binary aluminum–zirconium diagram. (tr-auth)

33898 HARDNESS OF OXYGEN DIFFUSION ZONES IN OXIDIZED MASSIVE ZIRCONIUM. Dubertret, Alain; Debuigne, Jean; Lehr, Pierre (CNRS, Vitry-sur-Seine, France). Compt. Rend., Ser. C, 262: 1571-4(June 1, 1966). (In French).

In the case of oxidized zirconium, the variation profile of the microhardness at the site of the metallic zone subjacent to the oxide was established. An interpretation is given on the basis of the hardness values of zirconium–oxygen solid solutions, published previously. (tr-auth)

33899 SIMPLIFIED METHOD FOR CALCULATING ELASTIC MODULI OF CERAMIC POWDER FROM COMPRESSIBILITY AND DEBYE TEMPERATURE DATA. Soga, Naohiro; Anderson, Orson L. (Columbia Univ., Palisades, N. Y.). J. Amer. Ceram. Soc., 49: 318-22 (June 21, 1966).

A method is presented for calculating the isotropic elastic moduli of ceramic powder from the compressibility and the Debye temperature. Young's and shear moduli of polycrystalline MgO, Al_2O_3, and TiO_2 were computed from compressibility and Debye temperature data by the present method and compared with values determined by the standard resonance method; values agreed within a few percent. An advantage of the present method is its applicability to specimens too small for the resonance method, because both compressibility and Debye temperature can be determined on powder or thin-film forms. (auth)

33900 THERMAL SHOCK RESISTANCE OF ZIRCONIA WITH 15 MOLE PERCENT TITANIUM. Arias, Alan (Lewis Research Center, Cleveland). J. Amer. Ceram. Soc., 49: 334-8(June 21, 1966).

The thermal shock resistance of zirconia with 15 mole % titanium prepared either by cold-pressing and vacuum-sintering or by vacuum hot-pressing was determined by radially quenching disks with thermally insulated faces under various conditions of heat transfer. The thermal shock resistance of calcia-stabilized zirconia disks was determined for comparison. For quenches from below the transformation temperature range of zirconia, the thermal shock resistance of zirconia with 15 mole % titanium was much better than that of calcia-stabilized zirconia, but for quenches from above the transformation range it was slightly inferior. The thermal shock resistance of zirconia with 15 mole % titanium is fairly insensitive to the methods of manufacture used in this investigation. In an attempt to identify the physical properties responsible for the improved thermal shock resistance of zirconia with 15 mole % titanium, the heat capacity, thermal expansion, modulus of rupture, modulus of elasticity, and thermal conductivity as functions of temperature were determined. (auth)

33901 MECHANISM BY WHICH METAL ADDITIONS IMPROVE THE THERMAL SHOCK RESISTANCE OF ZIRCONIA. Arias, Alan (Lewis Research Center, Cleveland). J. Amer. Ceram. Soc., 49: 339-41(June 21, 1966).

The relatively good thermal shock resistance of zirconia with 15 mole % titanium for quenches from below the transformation temperature of zirconia is attributed to the metal in the grain boundaries. The discrepancy between calculated and experimental thermal shock resistance of the same compositions for quenches through the transformation range is traced to the plastic behavior of these materials through the transformation range. The same type of plasticity was observed through the transformation range of zirconia–zirconium compositions. Metals other than titanium also improved the thermal shock resistance of zirconia. (auth)

33902 SOME MECHANICAL PROPERTIES OF URANIUM–10 MOLYBDENUM ALLOY UNDER DYNAMIC TENSION LOADS. Hoge, K. G. (Univ. of California, Livermore). J. Basic Eng., 88: 509-17(June 1966).

Dynamic tensile tests were conducted on uranium-10 weight percent molybdenum alloy in as-cast and wrought conditions. Carbon content was varied from 71 to 800 ppM. Heat treatment was also varied. Tests were conducted on a universal testing machine at strain rates of 4.8×10^{-5} and 0.057 in/in/sec and on a modified Dynapak at strain rates up to 100 in/in/sec. Tests were run from 75 to 600°F. Relatively low strain rates were used to determine the susceptibility to stress corrosion while the higher strain rates demonstrated the sensitivity of various mechanical properties to strain rate effects. (auth)

33903 PRE-$\alpha \rightarrow \beta$ TRANSFORMATION IN PLUTONIUM. Selle, J. E.; Etter, D. E. (Mound Lab., Miamisburg, Ohio). Contract AT(33-1)-Gen-53. J. Nucl. Mater., 19: 341-2(June 1966). (TID-22583).

The small endothermic reaction prior to the $\alpha \rightarrow \beta$ transformation in plutonium begins at 105°C and peaks at 110°C. This pre-$\alpha \rightarrow \beta$ transformation can be eliminated by an anneal at 100°C or by quenching from 150°C into a solid CO_2–acetone bath. Alloying with elements exhibiting solid solubility in various high-temperature allotropes eliminated this transformation. Four possible causes of this transformation (solution of impurities, formation of β phase, stress relief of the α phase, and formation of a small amount of microcracks) are discussed. An analysis of these possibilities led to the conclusion that the relief of stresses by the formation of microcracks is the primary cause for the endothermic reaction at 110°C. (J.S.R.)

33904 COMMENTS ON THE $\alpha \rightarrow \beta$ PRE-TRANSFORMATION OF PLUTONIUM. Spriet, B. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Nucl. Mater., 19: 343-4(June 1966). (In French).

The hypothesis that the $\alpha \rightarrow \beta$ pre-transformation of plutonium is caused by the formation of microcracks was critically examined, and it was concluded that this transformation is induced by stresses released in the α phase during a previous $\beta \rightarrow \alpha$ transformation. (J.S.R.)

33905 COMMENTS ON KINETICS OF THE $\alpha \rightarrow \beta$ AND $\beta \rightarrow \alpha$ TRANSFORMATIONS OF PLUTONIUM IN THE VICINITY OF EQUILIBRIUM. Nelson, R. D. (Battelle Memorial Inst., Richland, Wash.); Shyne, J. C. J. Nucl. Mater., 19: 345-7(June 1966).

Data on the $\alpha \rightarrow \beta$ and $\beta \rightarrow \alpha$ transformations in plutonium are presented, which suggest that both transformations proceed by a martensitic mechanism at all reaction temperatures. (tr-auth)

33906 INFLUENCE OF PURITY ON THE KINETICS OF THE $\alpha \rightleftharpoons \beta$ TRANSFORMATION OF PLUTONIUM. Spriet, B. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Nucl. Mater., 19: 348-50(June 1966). (In French).

The kinetics of the $\alpha \rightleftharpoons \beta$ was studied as a function of purity. The $\alpha \rightarrow \beta$ isothermal transformation curves were traced by resistivity measurements. The values of $\bar{n}$ for a metal with 4 ppM impurities passed from 1.7 to 4. For zone-purified plutonium with 2 ppM impurities the kinetics were almost independent of the stresses, and a constant speed of germination and growth is observed in the temperature range studied. Kinetics of the $\beta \rightarrow \alpha$ transformation showed that the transformation is completed up to temperatures of 80°C in plutonium with 200 ppM impurities. An increase of the purity causes a decrease in the transformation stresses and a modification of the transformation mechanisms in the case of $\beta \rightarrow \alpha$ transformation. (J.S.R.)

33907 DESIGNING WITH PLUTONIUM AND URANIUM. Henry, Charles R. (Univ. of California, Livermore). Mech. Eng., 88: No. 6, 28-37(June 1966).

The mechanical properties of plutonium and uranium are reviewed with respect to handling, machining, packaging, and designing into structures that will carry load. Fabrication, joining, and physical properties are discussed. (M.C.G.)

33908 POTASSIUM DIFFUSION INTO MONO- AND POLYCRYSTALLINE MOLYBDENUM. Benediktova, G. P.; Dubinin, G. N.; Kapman, M. G.; Shcherbedinskii, G. V. (Central Scientific-Research Inst. of Ferrous Metals, USSR). Metalloved. Term. Obrabotka Metal., No. 5, 55-7(May 1966). (In Russian).

Radioactive ^{42}K was used to obtain data on the diffusion of potassium in mono- and polycrystalline molybdenum at 800, 900, 1000, and 1100°C. The distribution of potassium concentration with sample depth was determined by sectioning the sample and counting the ^{42}K activity. The data were fitted to an equation of the following form: $D = D_0 \exp.(-Q/RT)$. The diffusion activation energy Q was 14,600 cal/mol for polycrystalline Mo, and 26,500 cal/mol for monocrystalline Mo. It was found that $D = 9.34 \times 10^{-3}$ exp. (–26,500/RT) for the monocrystal, and that $D = 2.86 \times 10^{-10}$ exp (–14,600/RT) [cm^2/sc] for polycrystalline Mo. By extrapolation of the data the potassium diffusion coefficients at 1500°C were found to be $D = 4.65 \times 10^{-12}$ cm^2/sec for polycrystalline Mo, and $D = 4.27 \times 10^{-12}$ cm^2/sec for monocrystalline Mo. The potassium diffusion coefficients in polycrystalline Mo were 2.5 to 5 times higher than in monocrystalline Mo. (TTT)

33909 HEAT TREATMENT FOR IMPROVING THE NOTCH TOUGHNESS OF HEAVY THICKNESS Mn–Mo STEEL PLATE FOR NUCLEAR REACTOR VESSELS. Susukida, Hiroshi; Ando, Tomozumi (Kobe Technical Inst., Japan). Mitsubishi Heavy Ind. Tech. Rev., 3: 156-65(May 1966).

Effects of quenching, tempering and stress relieving on the notch toughness of heavy thickness Mn–Mo steel plate (modified type) for nuclear reactor vessels were studied. The most effective method for improving the notch toughness was to increase the cooling rate from austenitized temperature. Stress relieving caused deterioration of the notch toughness. The critical cooling rate, at which Charpy V impact value exceeded 5.2 kg-m/cm^2 (30 ft-lb) at –12°C (10°F) after quenching, tempering, and stress relieving was about 10°C/min. The transition temperature Tr_{30} at one quarter of plate thickness after hot forming, quenching, tempering and stress relieving was –30°C and the NDT temperature was –25°C. Heat treatment standards for fabricating high-quality heavy-wall nuclear reactor vessels were established. (auth)

33910 CRYSTALLOGRAPHIC DATA ON NEW RARE EARTH-GERMANIUM AND SILICON COMPOUNDS. Smith, Gordon S.; Tharp, A. G.; Johnson, Quintin (Univ. of California, Livermore). Nature, 210: 1148-9(June 11, 1966).

The crystal structure of samarium–germanium compounds of the Sm_5Ge_4 composition was found. Five other lanthanide metals in combination with both germanium and silicon were examined. All the rare earths exhibited the orthorhombic 5 : 4 phase, when germanium was used. Terbium, erbium, and yttrium formed Sm_5Ge_4 type-compounds with silicon. Results with gadolinium and neodymium and silicon were not conclusive. (D.H.M.)

33911 PREVENTION OF CATASTROPHIC FAILURE IN STEEL PRESSURE CIRCUIT COMPONENTS. Nichols, R. W. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Nucl. Eng., 11: 369-73(May 1966).

A series of tests on the initiation and propagation of cracks from defects under service conditions is summarized. The implications of the results for the prevention of failures are discussed. (D.C.W.)

33912 EXPERIMENTAL STUDY OF THE FAILURE STRENGTH OF FLAWED STEEL PLATES. Quirk, A. (United Kingdom Atomic Energy Authority, Risley, Eng.); Finnear, T. C.; Fearnehough, G. D.; Nichols, R. W. Nucl. Eng. Design, 4: 39-53(May-June 1966).

The results of tensile tests on flawed wide steel plates are reported. The plates were, in general, 7 ft wide and 4 ft long, and flaws of 12 to 36 in. in length were investigated. Detailed consideration of the failure stress results revealed a number of features which did not appear consistent with other work. An experimental stress analysis on one specimen showed that these inconsistencies were due to the distribution of the applied load along the specimen. When the load was distributed uniformly across the specimen the results agreed very closely with the results of similar tests carried out on 5 ft dia. vessels. The work has been done in view to assess the influence of flaws on the strength of reactor pressure vessels. (auth)

33913 CREEP OF CONCRETE AT TEMPERATURES ABOVE NORMAL. Nasser, K. W. (Univ. of Saskatchewan, Saskatoon); Neville, A. M. Nucl. Eng. Design, 4: 90-6 (May-June 1966).

Data on creep of concrete, both mass and water cured, in the temperature range 70 to 205°F are presented, together

with results of subsequent creep recovery tests. Hence, observations on the viscous character of the creep deformation are made. Some information on creep of old concrete at temperatures above normal is given. Data on strength and elasticity of one mix within the same temperature range are presented. The purpose of the tests was to provide data necessary in the design of prestressed concrete reactor pressure vessels. (auth)

33914 CRYSTALLINE STRUCTURE OF LANTHANUM CHLORITE TRIHYDRATE: $La(ClO_2)_3.3H_2O$. Coda, Alessandro; Giuseppetti, Giuseppe; Tadini, Carla (Univ., Pavia, Italy). Period. Mineral., 34: 27-47(1965). (In Italian).

Crystallographic and x-ray diffraction studies revealed that crystals of lanthanum chlorite trihydrate are hexagonal bipyramidal. The unit cell and the space group, as determined from diffraction photographs obtained with MoK_α radiation, are: $a_0 = 8.07 \pm 0.02$ Å, $c_0 = 8.30 \pm 0.02$ Å, Z = 2, and space group: P $\bar{6}2$ c. The crystal structure was solved by Patterson projections along [01$\bar{1}$0] and [0001] with about 150 reflections hkio, hkil, hohl. The residuals for the only observed reflections were: R (hkio) = 7.0%, R (hohl) = 9.8%, and R (hkil) = 4.7%. The lanthanum atoms lie at (⅔, ⅓, ¼), (⅓, ⅔, ¾); their coordination number is nine: they are surrounded by three pairs of oxygen atoms superimposed along [0001] at nearly half a translation, giving a trigonal prism; and by three water molecules centering the prism faces. The water molecules lie on mirror planes at z = ¼; ¾ and are nearly superimposed along [0001]; they form hydrogen bridges with the ClO_2^- oxygens: the distance $(H_2O)-O$ is 2.89 ± 0.04 Å. The Cl^{3+} ions lie on the diads and connect the lanthanum coordination polyhedra. The main intramolecular distances were determined. (BBB)

33915 THE EFFECT OF MAGNETIC FIELDS ON THE MOESSBAUER SPECTRA OF Cu–Fe ALLOYS. Ron, M.; Rosencwaig, A.; Shechter, H.; Kidron, A. (Technion-Israel Inst. of Tech., Haifa). Phys. Lett., 22: 44-5(July 15, 1966).

Mössbauer studies on foils of Cu-Fe alloys indicate the presence of superparamagnetic particles and as well exhibit a decrease in the Lamb-Mössbauer factor f for the ferromagnetic components in the spectrum, when a weak transverse magnetic field is applied. This decrease in f is found to be saturated at about 3000 gauss. (auth)

33916 NEUTRON-DIFFRACTION INVESTIGATION OF CoO SINGLE CRYSTALS. Van Laar, B. (Reactor Centrum Nederland, Petten); Schweizer, J.; Lemaire, R. Phys. Rev., 141: 538-40(Jan. 1966). (RCN-49).

Neutron-diffraction data were obtained from CoO single crystals, cooled through the Néel point, while applying a small pressure. Thus, crystallographically almost untwinned, tetragonal crystals were obtained. The observed intensities can be explained either by the collinear-spin model given by Roth, with the assumption that any of the four possible antiferromagnetic domains occurs with exactly the same volume, or by the multi-spin-axis model proposed by van Laar. The results are compared with magnetic-torque measurements. (auth)

33917 EFFECT OF ORIENTATION ON THE YIELDING AND FLOW OF MOLYBDENUM SINGLE CRYSTALS. Guiu, F.; Pratt, P. L. (Imperial Coll. of Science and Tech., London). Phys. Status Solidi, 15: 539-52(June 1, 1966).

The influence of the orientation with respect to the direction of stresses was investigated over the temperature range 77 to 413°K. At temperatures below 300°K the limit of the proportionality of strain to stress and the rate of work-hardening depend markedly on the orientation. At temperatures above 300°K the yield stress is practically independent of the orientation and the crystals can experience a large elongation without necking. Crystals with the tensile axis orientated in a direction near the center of the unit stereographic triangle exhibit three work-hardening stages. Slip lines and etch pit observations have shown that profuse cross-slip of screw dislocations is a characteristic feature of the deformation of molybdenum single crystals. An explanation, based on the mobility of the jogs in screw dislocations, is proposed for the orientation dependence of the yield stress. (auth)

33918 DISSOCIATION OF DISLOCATIONS ON {110} PLANES IN ANISOTROPIC B.C.C. METALS. Vitek, V. (Central Research Inst. Skoda, Plzen, Czechoslovakia). Phys. Status Solidi, 15: 557-66(June 1, 1966).

The dissociation of dislocations with Burgers vectors ½ ⟨111⟩ and ⟨100⟩ on {110} planes in bcc metals is studied. An analysis of the possible dissociations is carried out for eleven bcc metals using anisotropic elasticity theory. For those dissociations which are found to be energetically favorable, the widths of the extended dislocations are computed as functions of the stacking fault energy. (auth)

33919 ANALYTICAL STUDY OF ISOCHRONAL ANNEALING OF COLD-WORKED NIOBIUM. Stals, L.; Nihoul, J.; Gevers, R. (SCK-CEN, Mol, Belg.). Phys. Status Solidi, 15: 717-23(June 1, 1966).

The theoretical expressions derived in a previous report are applied to stage III isochronal annealing data for cold-worked niobium. Close agreement between the experimental data and the theory is obtained by using the model based on uncorrelated bimolecular recombination of defects. This confirms an earlier proposed mechanism for stage III recovery in bcc metals, namely recombination of randomly migrating interstitials with immobile vacancies. (auth)

33920 HARDNESS AND DEFORMATION PROPERTIES OF SOLIDS AT VERY HIGH TEMPERATURES. Atkins, A. G.; Tabor, D. (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 292: 441-59(June 14, 1966).

An experimental study of the deformation and strength properties of refractory solids at temperatures up to 2000°C is described. It is difficult to make direct stress-strain measurements at elevated temperatures on small specimens of these materials, and consequently the strength property measured was indentation hardness. The problem of obtaining an indenter that is sufficiently hard and stable at these temperatures was overcome by indenting a cylinder or prism of the material with an identical specimen of the same material. Mutual indentation measurements obtained in this way show that at low temperatures most of the refractory solids are very hard but brittle. Above a critical temperature they become ductile and the hardness falls as the temperature increases. With sintered porous specimens the fall in hardness is augmented by collapse of the structure and compaction of the material. At higher temperatures the behavior is dominated by the intrinsic properties of the solid and the hardness properties of the sintered material resemble those of fully compacted crystalline specimens. For most of the refractory solids, as for pure metals, the most rapid fall in hardness occurs at temperatures above about one-half of the absolute melting point, T_m. By contrast the carbides of titanium and tungsten fall off rapidly in hardness at temperatures between 0.2 and $0.4T_m$, probably on account of the increased mobility of the carbon atoms. At any one temperature the indentation hardness decreases as the loading time is increased. Semi-empirical relations may be used to describe this and it is possible to deduce an activation energy for the creep processes involved. The results show that the only materials having an indentation hardness above 100 Kg/mm² at 1500°C are the nitrides and carbides of silicon. (auth)

33921 HIGH-TEMPERATURE MECHANICAL BEHAVIOR OF U–C ALLOYS WITH COMPOSITION CLOSE TO THAT OF MONOCARBIDE AND FORMING OF THESE ALLOYS BY EXTRUSION. Accary, A.; Magnier, P.; Marchal, M. (CEA, Saclay, France). Rev. Hautes Temp. Refract., 3: 59-77(Jan.-Mar. 1966). (In French).

The mechanical properties of U–C systems are described as a function of the composition and the temperature. The techniques permitting the application of the extrusion method to the forming of refractory uranium carbides are described. The various factors affecting the characteristics

of the products obtained in the extrusion process were determined. The properties of the extruded systems are described. It is shown that the high-temperature plasticity of the uranium–carbon systems is connected with the carbon content of the systems. Systems containing free intergranular uranium are rapidly deformed under low forces at 1600°C. In this case there is no unequivocal relation between the carbon concentration and the behavior of the system since the velocity of deformation depends largely on the grain size. Systems consisting of a pure UC phase or by the presence of the dicarbide can be taken to 2300°C before undergoing equivalent deformations. The plasticity of these systems was sufficient to permit extrusion, and the best temperature range for this operation was between 2280 and 2350°C, regardless of the carbon concentration of the systems. The utilization of graphite for the production of wires to extend the classical extrusion technique for uranium monocarbides to the formation of uranium dicarbides and the dicarbides of thorium and its alloys is described. (J.S.R.)

33922 DIFFUSION OF XENON IN IRON. Gorun, M.; Rutter, I.; Radulescu, O. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 11: 191-200(1966).

The equipment and the experimental procedure used to investigate the fission-gas release during postirradiation heating of recoil impregnated metals are described. Measurements were carried out at 600, 700, 800, 900, and 950°C of the release of ^{133}Xe recoiled into Armco iron foils during neutron irradiation in contact with UO_2 films deposited on aluminum. The pattern of the release from iron was the same as that observed by others from iron–20 wt % chromium alloy and some ceramic oxides: a high rate of loss of ^{133}Xe for several minutes followed by a slower release for which the cumulative fractional release was linear with the square root of the heating time. The advantageous initial distribution of the xenon into the sample and the fact that relative measurements were made led to the decreasing of errors below 5%. (auth)

33923 GRAIN BOUNDARY GROOVING IN URANIUM DIOXIDE. Amato, I.; Colombo, R. L.; Grappiolo, G. C. (FIAT, Turin). Solid State Commun., 4: 237-9(May 1966).

Thermal grooving experiments were performed on uranium dioxide specimens containing a stable grain boundary lattice. Thermal groove profiles were established with the aid of an interferometric microscope: the presence of the two hills at both sides of the grooves indicated that the material transport mechanism was controlled by diffusion, according to Mullins' theory. The mathematical treatment of the behavior of the groove width as a function of time and temperature suggests rather a volume-diffusion than a surface-diffusion controlled process. (auth)

33924 COMPATIBILITY STUDIES OF URANIUM–PLUTONIUM–ZIRCONIUM FUELS WITH IRON-BASE CLADDING ALLOYS. Zegler, S. T.; Walter, C. M. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 2-3(June 1966).

33925 CALORIMETRIC STUDIES OF DELTA, DELTA PRIME, AND EPSILON PLUTONIUM. Engel, T. K. (Monsanto Research Corp., Miamisburg, Ohio). Trans. Amer. Nucl. Soc., 9: 3-4(June 1966).

33926 LIQUID PLUTONIUM—REVIEW OF ITS UNUSUAL PROPERTIES. Ofte, D.; Rohr, W. G.; Wittenberg, L. J. (Monsanto Research Corp., Miamisburg, Ohio). Trans. Amer. Nucl. Soc., 9: 5-6(June 1966).

33927 EFFECT OR POROSITY ON THERMAL CONDUCTIVITY OF CERAMIC BODIES. Biancheria, A. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 15(June 1966).

33928 THERMAL CONDUCTANCE OF ThO_2–10 UO_2 UNDER SIMULATED OPERATING CONDITIONS. Harbinson, E. N.; Walker, R. J. (Babcock and Wilcox Co., Lynchburg, Va.). Trans. Amer. Nucl. Soc., 9: 26-7(June 1966).

33929 THERMODYNAMIC PROPERTIES OF PLUTONIUM MONONITRIDE FROM ELECTROMOTIVE FORCE MEASUREMENTS. Campbell, G. M.; Leary, J. A. (Los Alamos Sciencific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 43(June 1966).

33930 URANIUM PHASE DIAGRAMS AND A SOLID SOLUBILITY CORRELATION. Park, John Joseph. College Park, Md., Univ. of Maryland, 1965. 72p.

Thesis.

The binary phase diagrams for the uranium-ruthenium and the uranium-rhodium systems were constructed from data accumulated by thermal analysis, x-ray diffraction, and metallographic examination. The reactions and the temperatures of reaction, the intermetallic compounds, and the respective solid solubilities were determined for each of the systems. From the liquidus curves, the activity of uranium in the liquid solution was calculated over the full composition range for each of the binary systems. From the activity data, the heats of solution were calculated for the compositions at which the intermetallic compounds are formed. A successful correlation was obtained in comparing the solid solubilities of various elements in gamma-uranium. By determining the atomic radius of each element at the temperature of reaction and comparing that with the atomic radius for the atoms of the gamma-uranium lattice, an atomic radius ratio can be obtained; an ionization potential ratio may be obtained in the same manner. A plot of these data points serves to group elements of similar solid solubility in gamma-uranium, and a strong dependence on the solute's cubic lattice is evident. This correlation was also applied to the solid solubility of face-centered cubic elements in gamma-iron, and an excellent correlation was obtained. (Dissertation Abstr.)

33931 DENSIFICATION AND SINTERING OF THORIA AND THORIA GELS. Daniels, Alma Uriah Jr. Salt Lake City, Utah, Univ. of Utah, 1966. 208p.

Thesis.

The initial densification of thorium oxide prepared as a solid gel from steam-denitrated thoria, and prepared as compacts of crushed gel, and compacts of calcined thorium oxalate powder was studied by continuous isothermal shrinkage measurements made with a recording dilatometer. The gel material exhibited shrinkage due to water loss at temperatures below 600°C and shrinkage due to plastic flow and grain boundary diffusion sintering in the region from 600° to 1000°C. The sintering process was studied in detail. Because of the small thoria particle size (70 to 140Å) in the solid gel, the material sintered to 98.2% of thoria's theoretical density in 200 minutes at 100°C. Linear isothermal shrinkage measurements on crushed gel compacts showed rapid initial shrinkage of up to 5%, probably due to surface diffusion and plastic flow, which was activated by temperature increase and by adsorbed water vapor. A general equation for one-mechanism diffusion sintering was derived giving the time dependence of isothermal shrinkage. A method for the calculation of initial sintering boundary conditions from an arbitrary portion of the shrinkage data was developed and used in the form of a Fortran IV computer program. Application of this equation to crushed gel compacts showed that after the rapid initial shrinkage, at least 6% shrinkage occurred by grain boundary diffusion sintering. Measurements in N_2-H_2O and $Ar-H_2$ atmospheres identified $O^=$ vacancies as the diffusion-controlling species. The activation energy for diffusion sintering in air was 39.0 kilocalories/mole. Calcined thorium oxalate compacts also showed isothermal grain boundary diffusion shrinkage, but the activation energy was only 18.9 kilocalories/mole. This may have been due to a high vacancy concentration in the relic structure left after calcination. (Dissertation Abstr.)

33932 STRENGTH AND STRUCTURE OF ENGINEERING MATERIALS. Polakowski, N. H.; Ripling, E. J. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1966. 551p.

An introduction is presented to the mechanics of deformation and fracture of solids, combined with a discussion

of the physical meaning of each of the important mechanical properties. Subjects covered are: analysis of stress; analysis of strain; classification and structure of engineering materials; elasticity; plastic deformation; plasticity of crystalline materials; time-dependent deformation; fracturing; tensile properties; properties under compressive loads; hardness; bending; torsion and shear; properties that measure fracture resistance; creep and stress rupture; residual stresses; and cyclic stress and fracture by fatigue. (D.H.M.)

33933 FAZOVYE PREVRASHCHENIYA V METALLAKH I SPLAVAKH. (Phase Transformations in Metals and Alloys). Respublikanskii Mezhvedomstvennyi Sbornik. Seriya Metallafizika. (Interdepartmental Collections. Metal Physics Series). Kiev, Naukova Dumka, 1965. 176p.

This is one of a series of books on the physics of metals. It deals with such subjects as the theory of the perlite-austenitic transformation on heating of steel, the breakdown of bcc binary alloys, the effects of pressure on the ordering of fcc alloys of the $AuCu_3$ type, the anomalous heat capacity of ordered alloys at temperatures above the order-disorder transition, the effects of insoluble impurities on grain size and recrystallization, the formation of austenitic steel during rapid electron heating, the change in paramagnetic properties and structure of NiPt and Ni_3Pt during ordering, the effects of alloying on the structural stability of Cd_3Sb_2 in the Cd–Sb system, the effects of internal work hardening on stabilizing the reverse martensitic conversion, the recrystallization kinetics of strongly deformed single crystals of nickel and niobium, the breakdown of a supersaturated solid solution of tungsten in cobalt, the effects of aluminum on structural changes in nickel during creep, phase diagrams of the Cr–Nb–Mo and Hf–Cr systems, and cerium purification by zone melting. Separate abstracts were prepared for 3 of the chapters. (TTT)

For abstracts of individual chapters see: 33934–33936.

33934 RECRYSTALLIZATION KINETICS IN STRONGLY DEFORMED NICKEL AND NIOBIUM MONOCRYSTALS. Larikov, L. N.; Zasimchuk, E. E.; Semenenko, M. N. (Inst. of Physics of Metals, Academy of Sciences, Ukrainian SSR). pp 118-26 of Fazovye Prevrashcheniya v Metallakh i Splavakh. Kiev, Naukova Dumka, 1965. (In Russian).

The number of recrystallized grains per unit area of polished section, N, and the rate of formation of recrystallization centers, $\dot{N}$, in nickel and niobium single crystals were found to be given by the following equations: $N = \bar{N}\{1 - \exp[-I_s \tau \exp(-t_H/\tau)]\}$ and $\dot{N} = I_s \bar{N} \exp[(-t_H/\tau) - I_s \tau](1 + t_H/\tau)$, where $\bar{N}$ is the average number of potential recrystallization centers in the deformed matrix, I_s is the stationary frequency of occurrence of the centers (at $\tau \gg t_H$), and t_H is the nonstationary period. With niobium at temperatures of 965, 1005, and 1040°C, respectively, the values of I_s are 1.0, 2.0, and $11.0 \times 10^4/cm^2$ sec; the values of $\bar{N}$ are 2.4, 2.4, and $2.8 \times 10^{-3}/cm^2$, and values of t_H are 5, 3, and 0.5 hours, respectively. These values are also given for nickel at temperatures of 288, 313, and 334°C. A small induction period in the growth of recrystallization centers is noted. (TTT)

33935 STRUCTURAL CHANGES DURING DISINTEGRATION OF SUPERSATURATED SOLID SOLUTIONS OF TUNGSTEN IN COBALT. Larikov, L. N.; Polotskii, I. G.; Mordyuk, N. S.; Shmatko, O. A. (Inst. of Physics of Metals, Academy of Sciences, Ukrainian SSR). pp 127-31 of Fazovye Prevrashcheniya v Metallakh i Splavakh. Kiev, Naukova Dumka, 1965. (In Russian).

A homogeneous W–Co alloy containing 31.89% W was prepared by melting under argon, holding in vacuum at a temperature >1100°C for 15 hours, and quenching in water. This W content was close to the solubility limit of tungsten (32%) at the peritectoid temperature of 1100°C. With an isothermal anneal of the alloy at a temperature of 700°C, quantitative metallography showed a breakdown of the supersaturated tungsten solution after 30 minutes aging, which became quite extensive after 7 hours aging. X-ray analysis showed an increase of α-Co and a decrease in the amount of β-Co with increasing aging time at 700°C. The hardness of the precipitate indicated the formation of the intermetallic compound Co_3W. Changes in volume and in Young's modulus pointed to the heterogeneous breakdown of a supersaturated solution of tungsten in cobalt. (TTT)

33936 PHASE EQUILIBRIUM DIAGRAM IN THE CHROMIUM–NIOBIUM–MOLYBDENUM SYSTEM. Svechnikov, V. N.; Kobzenko, G. F. (Inst. of Physics of Metals, Academy of Sciences, Ukrainian SSR). pp 147-58 of Fazovye Prevrashcheniya v Metallakh i Splavakh. Kiev, Naukova Dumka, 1965. (In Russian).

Differential thermal and x-ray structural analyses were the main methods used to define the Cr–Nb–Mo system. Microstructural analysis, dilatometry, and hardness determinations were used as supplemental aids. The alloys were prepared in an electric arc furnace under purified argon. Isothermal anneals were carried out at 1700°C (70 hr), 1600 (97), 1550 (100), 1500 (50), 1350 (55), 1300 (200), 1275 (85), 1225 (100), 1115 (200), 1000 (400), and 800 (900 and 1100). A total of 78 binary alloys and 223 ternary alloys were investigated. The results are presented in the form of isothermal sections at temperatures of 1000, 1115, 1225, 1275, 1350, and 1550°C with triangular coordinates for the wt. % of Cr, Mo, and Nb. The single-phase two-phase and three-phase states are indicated. A general view of the equilibrium phase diagram of the Cr–Nb–Mo system is presented. (TTT)

33937 THE HEAT CAPACITY OF BERYLLIUM BELOW 30 DEG K. Ahlers, Guenter (Bell Telephone Labs., Inc., Murray Hill, N. J.). 21p. (CONF-651015–9). ORAU. Gmelin, AED-CONF-65-312-6.

From American Physical Society Meeting, Chicago.

The heat capacity of high purity beryllium ($R_{300}/R_{4.2}$ = 1100) was measured from 1.4 to 30°K. The results can be expressed by the sum of contributions proportional to T, T^3, and T^5, with the coefficients (0.1714 ± 0.0008) $mJ/M(°K)^2$, $(0.598 \pm 0.020) \times 10^{-3}$ $mJ/M(°K)^4$, and $(0.18 \pm 0.04) \times 10^{-6}$ $mJ/M(°K)^6$, respectively. The Debye theta at 0°K (θ_0) is (1481 ± 16)°K. The results are in good agreement with some of the recent lattice dynamical and band structure calculations and with θ_0 derived from elastic constants. Phonon enhancement of the density of states does not appear important in beryllium. The heat capacity is smaller than the work of previous investigators indicated. (auth)

Radiation Effects

See also CHEMISTRY — Radiation Chemistry

Refer also to abstracts 33604 and 34778.

33938 (CEA-R-2943) ETUDE PAR DIFFRACTION DES RAYONS X DE GLUCINE IRRADIEE AUX NEUTRONS. (X-Ray Diffraction Studies of Neutron-Irradiated Beryllium Oxide). Belbeoch, Bella; Rodot, Janine; Roulliay, Monique (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1966. 54p. Dep. mn.

X-ray diagrams of neutron irradiated sintered BeO (E > 1 Mev) can be classified into 3 types depending on the value of the c/a ratio, independently of the characteristics of the sinters (hot pressed or cold pressed material, variable density and grain size, pure BeO or BeO with additions). The radioinduced anisotropic expansion of the BeO lattice depends on the irradiation dose and on the intergranular stresses of the samples. The sintered samples which resist irradiation most satisfactorily consist of cold-pressed high-density and small-grain-size material for which the c/a ratio varies little with increasing dosage. The single-crystal diagrams show the same classification as the polycrystalline material in respect with the c/a ratio, and in addition to the Bragg reflections, x-ray diffusions are observed. It appears that defects start to congregate and cause pronounced distortion of the lattice. The defects

are stabilized in the form of large aggregates only when a later irradiation stage is reached. (auth)

33939 (DP–1051) PROPERTIES OF ^{60}Co AND COBALT METAL FUEL FORMS. Windley, William C. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 1966. Contract AT(07-2)-1. 25p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A compilation of ^{60}Co properties and Co metal properties is presented. Preliminary information is included concerning compatibility of Co with encapsulating materials. Data specific to radioactive Co are distinguished from data on unirradiated Co. (J.R.D.)

33940 (DP-MS–66-1) ADVANCES IN NaK ENCAPSULATION TECHNIQUES AT THE SAVANNAH RIVER LABORATORY. Rankin, W. N.; Sturcken, E. F.; McDonell, W. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr. 25, 1966. Contract AT(07-2)-1. 15p. (CONF-660511–9). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Symposium on Capsule Irradiation Experiments, Pleasanton, Calif.

Preparations for testing irradiation growth and cavitation swelling in U and U alloys were investigated. The capsule loading chamber was modified to double the number of capsules that can be loaded at one time. A new method was developed for sealing the capsules. The vacuum system was improved, and the pump-down time reduced by a factor of ten. Other modifications were introduced that simplify and increase the safety during the mounting, filling, and sealing of the capsules and the removal of NaK from the system after loading. Advances were also made in test specimen design. Techniques were developed for strain-free machining of spherical specimens, and for directionally indexing them with rectangular holes. The spherical specimen greatly reduces the necessary number of test specimens for irradiation growth experiments, since data for growth in all directions can be obtained from a single specimen. (J.R.D.)

33941 (DP-MS–66-9) METALLOGRAPHY OF SCANDIUM, THULIUM, AND ERBIUM TARGETS BEFORE AND AFTER IRRADIATION. Livingston, J. T.; Angerman, C. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). June 9, 1966. Contract AT(07-2)-1. 14p. (CONF-660518–6). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 20th Metallographic Group Meeting, Rocky Flats, Colo.

The microstructures of metallic Sc and Tm and their oxides, and of Er_2O_3 were characterized before and after irradiation. Standard polishing and etching techniques were used. The examinations were made either on a shielded metallograph, when the specific activities were about 600 curies per gram, or by replica electron microscopy, when the gamma activity was above permissible limits for the metallograph. The effects of irradiation were minor. Trace impurity phases in Tm and Sc metal disappeared. Grain growth was observed in Tm metal and Er_2O_3. Porosity increased in Sc_2O_3, and decreased in Er_2O_3. (auth)

33942 (IDO–17157) ATR FUEL MATERIALS DEVELOPMENT IRRADIATION RESULTS. PART II. Walker, V. A.; Graber, M. J.; Gibson, G. W. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). June 1966. Contract AT(10-1)-205. 110p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

Irradiation experiments upon fuel materials selected for use in the Advanced Test Reactor and the High Flux Isotope Reactor and possible substitutes were executed at conditions prototypical of full-power operation in a loop facility in the Engineering Test Reactor. The fuel materials behaved satisfactorily with respect to fuel dimensional stability during the irradiations. The materials tested included 41 wt % U_3O_8 with 0.19 wt % B_4C 51 wt % UAl_3 with 0.19 wt % B_4C 55 wt % UAl_3 with 0.19 wt % B_4C 56 wt % Nb-coated UO_2-ZrO_2 with 0.16 wt % B_4C and 41 wt % U_3O_8. The matrix and cladding materials for all compositions were X8001 Al and 6061-0 Al, respectively. Post-irradiation anneal experiments on plates containing the nominal ATR fuel and poison loadings showed the threshold temperature for breakaway swelling to be 750°F for the U_3O_8 fueled plates and 800°F for UAl_3 plates which had a fission density of 15×10^{20} f/cc. The breakaway swelling temperature for a Nb-coated UO_2-ZrO_2 plate with the same ^{235}U and ^{10}B content was 500°F with a fission density of 11×10^{20}. (auth)

33943 (N–65-32165) LOW-TEMPERATURE ANNEALING OF THE ULTRASONIC ATTENUATION IN PRESTRAINED LiF AFTER ^{60}Co GAMMA IRRADIATION AT LIQUID NITROGEN TEMPERATURE. Yabe, Masaya (William Marsh Rice Univ., Houston, Tex. Dept. of Mechanical Engineering). [1963]. 29p. (NASA-CR–59311). CFSTI $2.00 cy, $0.50 mn.

The effect of γ irradiation at liquid nitrogen temperature on the low temperature internal friction of compressed LiF crystals was studied by the ultrasonic pulse method at a frequency of 10 Mc/s. The internal friction is substantially increased in compressed LiF crystals after a 5.8×10^6 R dosage of γ rays at 77°K. It was noted that this enhanced internal friction irreversibly decreases during uniform heating between 83 to 110°K. The latter result is compared with the available data concerning annealing of electron spin resonance, optical absorption, and mechanical properties in the same temperature region. A new method of analyzing internal friction data to obtain the activation energy and jump frequency of the mobile pinning point defects is described. This was accomplished by measuring the internal friction while the specimen warmed up at a low linear rate because of the large heat capacity and low thermal conductivity of LiF. According to this analysis, the activation energy of migration of the H center in LiF is determined to be 0.103 ± 0.004 ev. (auth)

33944 (N–65-34010) RADIATION EFFECTS ON SILVER AND ZINC BATTERY ELECTRODES. Interim Report, April–July 1965. Argue, G. R.; Recht, H. L.; McCollum, W. A. (Atomics International, Canoga Park, Calif.). Aug. 16, 1965. Contracts NAS7-100; JPL-951109. 23p. (NASA-CR–64970; AI–65-158). CFSTI $1.00 cy, $0.50 mn.

For Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

Studies are underway to determine the level at which radiation damage would start in an Ag–Zn system. Cadmium electrodes were substituted for zinc as excessive growth of dendrites occurred during initial capacity measurement cycles. Material lost from the silver electrode was observed on the bottom of the cell after every irradiation. One silver electrode with a capacity of 0.8A-h lost 54 mg of material after a gamma dosage of 1.1×10^8 rads (H_2O); an identical unirradiated electrode at the same temperature (45°C) and cycling conditions lost only 4.1 mg of material. Small gamma radiation dosages proved sufficient to initiate precipitation of silver metal from the solution containing a charged silver electrode; the effect was observed after a 5-min irradiation [10^5 rads (H_2O)]. The precipitated silver metal appeared to be the product of radiation-induced reduction of silver oxides in solution. (STAR)

33945 (NUMEC–3505-14) $PuO_2-UO_2-ZrO_2$ FUEL DEVELOPMENT PROGRAM. Annual Progress Report, March 1, 1965–February 28, 1966. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Apr. 25, 1966. Contract AT(30-1)-3505. 96p. (EURAEC–1655). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Studies were initiated to develop the $PuO_2-UO_2-ZrO_2$ fuel system. This fuel system has potential application for plutonium recycling in present-day thermal reactors now fueled with slightly enriched uranium. The ternary fuel compositions to be investigated include 4, 6, 10, and 12 vol % PuO_2 in conjunction with 25, 50, and 75 vol % ZrO_2, with the remainder UO_2. Methods were developed for the preparation of sinterable-grade powder and the fabrication of high-density pellets. Powder was prepared by both

ternary coprecipitation and mechanical mixing routes. Coprecipitation was carried out by a modified ADU process from mixed nitrate feed solutions. Mechanical blends were obtained by ball milling mixtures of PuO_2, UO_2, and ZrO_2 powders of controlled particle size, followed by granulation, sintering, and ball milling. Pellets were fabricated by automatic pressing without binder and sintered in a continuous pusher furnace. Single-phase fcc ternary oxide pellets resulted from both routes for 25 and 50 vol % ZrO_2 mixtures containing 6 and 10 vol % PuO_2, indicating phase stabilization by plutonium dioxide. The 75 vol % ZrO_2 compositions with 4, 6, and 10 vol % PuO_2 contained 10 to 20% of a monoclinic ZrO_2-rich second phase in equilibrium with the fcc major phase. Addition of 15 vol % CaO did not eliminate the second phase. Fuel melting points measured with a ribbon furnace ranged from 2566 to 2645°C with a slight depression at the 50 vol % ZrO_2 composition. The lattice expansion averaged 9.7×10^{-6}/°C up to 1500°C. Fuel pellets of all compositions remained stable under repetitive thermal cycling to 1700°C. Oxidation in air at 700°C resulted in fragmentation of the 25 and 50 vol % ZrO_2 pellets while the 75 vol % ZrO_2 shapes remained intact. Weight gain data indicated that the ternary oxide pellets were substoichiometric. Irradiation capsules were designed and fabricated to test fuel performance at a linear heat generation rate of 450 w/cm. Three capsules will be inserted in GETR-RAFT during May, 1966, for planned burnups of 9,000, 30,000, and 48,000 MWD/T ternary oxide fuel. (auth)

33946 (ORNL-TM-1516) IRRADIATION EMBRITTLEMENT OF LOW- AND HIGH-CARBON STAINLESS STEELS AT 700, 800, AND 900 DEG C. Martin, W. R.; Weir, J. R. Jr. (Oak Ridge National Lab., Tenn.). June 1966. Contract W-7405-eng-26. 27p. (CONF-660613-1). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From US/UK Libby-Cockcroft Irradiation Effects Meeting, Upton, N. Y.

Reactors, such as the nuclear superheat, gas-cooled, and liquid-metal, require structural and cladding material applications in the temperature range from 500 to 900°C. It was previously shown that the postirradiation ductility of type 304 stainless steel at elevated temperature is practically independent of irradiation temperature up to 700°C. Studies of irradiation temperature were extended into the temperature range from 700 to 900°C. In general, the ductility of the irradiated alloy decreased with increasing irradiation temperature when these ductilities were determined at tensile test temperatures within the 650 to 842°C temperature range. A marked difference in the ductility of low- and high-carbon irradiated stainless steels was observed, which appeared to be related to the quantity of grain-boundary carbides. These data are interpreted as indicating that grain-boundary carbides formed in irradiated materials in this temperature range are capable of increasing the stress at which wedge-type grain-boundary cracks are nucleated and also reducing the rate of crack propagation. Agglomerated carbides in the grain boundary appear capable of reducing the magnitude of irradiation embrittlement. (auth)

33947 EVAPORATION OF THIN METALLIC SAMPLES INDUCED BY FISSION FRAGMENTS. Gorshkov, V. K.; L'vov, L. N. At. Energ. (USSR), 20: 327-30(Apr. 1966). (In Russian).

It was shown that thin sources prepared from salts containing ^{242}Cm and ^{244}Cm evaporated under the action of fission fragments. The fragments passing along the surface of the source produced the most pronounced effects. The number of atoms evaporating increased with the source thickness (h) and reached a maximum at $h = 1.5 \times 10^{-6}$ cm. (G.O.Y.)

33948 INFLUENCE OF IRRADIATION UPON THE DISLOCATION DAMPING AND ELASTIC CONSTANTS OF METALS. Saxl, Ivan (Inst. of Nuclear Research, Czechoslovak Academy of Science, Rez). Cesk. Cas. Fys., 16: 349-89(1966). (In Czech).

A survey of experimental data on the effects of nuclear radiation upon dislocation damping and the elastic constants of metals is given. The bibliography of books and papers (especially theoretical) on the three main topics concerned, i.e., dislocation damping, interaction between dislocations and point defects and radiation damage in metals is discussed. The various kinds of dislocation damping, i.e., amplitude independent damping, amplitude dependent damping and the Bordoni peak, are treated separately. The change of true elastic constants is also briefly covered. Annealing studies on low temperature irradiated samples are given special attention and the results are discussed with regard to current models of the defect motion underlying the recovery processes. The information gained from studies of amplitude dependent damping that could contribute to an understanding of the nature of radiation hardening, is thoroughly discussed. Attention is focused mainly on copper because of the large amount of data available. (auth)

33949 DIFFUSION STAGES IN AN IRON-50 NICKEL ALLOY IRRADIATED WITH ELECTRONS AND NEUTRONS. Chambron, William; Chamberod, Andre; Pauleve, Jean (Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., Ser. C, 262: 1417-20(May 9, 1966). (In French).

Annealing in a magnetic field of iron-50% nickel alloys irradiated at 77°K with neutrons and at 20°K with electrons shows the existence of several stages of establishment of uniaxial magnetic anisotropy; the diffusion in each stage is due to a fault or a distinct mechanism. Magnetic permeability measurements and electric resistance measurements complete the study. (tr-auth)

33950 CARBIDE PRECIPITATION AND ASSOCIATED TENSILE BEHAVIOR IN A NEUTRON-IRRADIATED STAINLESS STEEL. Higgins, P. R. B.; Roberts, A. C. (Atomic Energy Research Establishment, Harwell, Eng.). J. Iron Steel Inst. (London), 204: 489-94(May 1966). (AERE-R-4565).

The effects of neutron irradiation at 50°C on the tensile and precipitation behavior at 850°C of a 20% Cr, 25% Ni, niobium-stabilized austenitic steel were studied. Irradiation caused an increase in the proof and ultimate tensile stresses and a reduction in the ductility. Optical and electron microscopy showed that irradiation affects both the amount and distribution of precipitates within the grains. In irradiated specimens precipitation occurred along crystallographic directions and extended up to the grain boundaries, while in unirradiated specimens there was a denuded region near the grain boundaries and random precipitation in the center of the grains. After annealing at 1150°C for 30 min, the proof and ultimate tensile stresses of irradiated and control specimens were not significantly different, but the ductility loss of irradiated specimens was not recovered. There was no significant difference in the amount or distribution of the precipitates. It is therefore likely that the reduced ductility in irradiated specimens is due to the presence of helium, formed by the transmutation of ^{10}B, at the grain boundaries. These helium bubbles grow under the combined action of stress and temperature and develop into the observed intergranular cracks. (BBB)

33951 STUDY OF IRRADIATION DEFECTS BY MEANS OF MAGNETIC CREEP IN IRON. Moser, P. Mem. Sci. Rev. Met., 63: 343-74(Apr. 1966). (In French).

A study was made of the behavior of irradiated iron using the magnetic creep method, which gives ample information on the symmetry, reorientation, and healing of the defects examined. The method reveals extremely small fault concentrations but it is time-consuming. (auth)

33952 RADIATION DAMAGE EFFECTS IN CRYSTALS. Martin, D. G. (Atomic Energy Research Establishment, Harwell, Eng.). Sci. Progr. (London), 54: 209-25(Summer 1966).

Radiation damage effects in solids may be grouped broadly under two headings. The first concerns the slowing down of energetic atoms and the production of lattice defects, while the second relates to the thermal migration and eventual disappearance of these defects. Examples of focusing and channelling effects, and the identification of various sizes of defect clusters are given. (auth)

33953 IRRADIATION PERFORMANCE OF LIQUID PLUTONIUM–COBALT–CERIUM ALLOYS. Basmajian, John A.; Kirkbride, L. D. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 4(June 1966).

33954 IRRADIATION OF LIQUID-PLUTONIUM FAST-REACTOR FUELS IN A THERMAL REACTOR. Ragan, G. L.; Cubitt, R. L. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 4-5(June 1966).

33955 NEW MODEL FOR GAS RELEASE FROM IRRADIATED CERAMICS. de Bruin, H. J.; Kairaitis, D. (Australian Atomic Energy Commission, Sutherland, New South Wales). Trans. Amer. Nucl. Soc., 9: 15-16(June 1966).

33956 POSTIRRADIATION STRUCTURES IN UO_2 QUENCHED OR SLOWLY COOLED FROM THE MELT. Bain, A. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 9: 27-8(June 1966).

33957 PERFORMANCE OF PYROLYTIC-CARBON-COATED URANIUM-OXIDE PARTICLES DURING IRRADIATION AT HIGH TEMPERATURES. Reagan, P. E.; Morgan, J. G.; Sisman, O. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 28-9(June 1966).

33958 POST-EXAMINATION OF UO_2–5 PuO_2 FUELS. Ross, W. J.; Puechl, K. H.; Caldwell, C. S.; Miles, J.; Shipko, F.; Judd, W. C. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Trans. Amer. Nucl. Soc., 9: 40-1(June 1966).

33959 HWOCR FUEL-IRRADIATION TEST. Arneson, S. O. (Atomics International, Canoga Park, Calif.); Young, R. H.; Chernock, W. P. Trans. Amer. Nucl. Soc., 9: 48-9(June 1966).

33960 FAST-REACTOR IRRADIATION EFFECTS ON TYPE 316L AND 17-4 PH STEELS. Martin, W. R. (Oak Ridge National Lab., Tenn.); Weir, J. R. Jr.; Basmajian, J. A.; Kirkbride, L. D. Trans. Amer. Nucl. Soc., 9: 50-1(June 1966).

33961 BURST TESTS ON STAINLESS-STEEL TUBULAR FUEL JACKETS IRRADIATED TO 10^{22} n/cm^2 IN A FAST-FLUX REACTOR (EBR-II). Murphy, W. F.; Strohm, H. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 51(June 1966).

33962 RADIATION DAMAGE IN INCONEL-625, INCOLOY-825, AND HASTELLOY-X. Busboom, H. J. (General Electric Co., San Jose, Calif.); Spalaris, C. N.; Francke, P. Trans. Amer. Nucl. Soc., 9: 51-2(June 1966).

33963 EFFECTS OF NEUTRON IRRADIATION ON THE CREEP-RUPTURE PROPERTIES OF HASTELLOY N. Smith, J. P.; Lovell, A. J.; Kingsbury, F. D.; Moteff, J. (General Electric Co., Cincinnati). Trans. Amer. Nucl. Soc., 9: 52-3(June 1966).

33964 EFFECT OF IRRADIATION ON THE TENSILE PROPERTIES OF ZIRCALOY-2, INCOLOY-800, AND INCONEL-600. Coplin, D. H.; Pashos, T. J.; Lyons, M. F.; Weidenbaum, B. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 9: 53-4(June 1966).

33965 THERMAL HARDENING OF NEUTRON-IRRADIATED POLYCRYSTALLINE TUNGSTEN. Lovell, A. J.; Kingsbury, F. D.; Moteff, J. (General Electric Co., Cincinnati). Trans. Amer. Nucl. Soc., 9: 54-5(June 1966).

33966 EFFECT OF LOW-TEMPERATURE DEUTERON IRRADIATION ON SOME SUPERCONDUCTORS. Keller, E. L.; Coffey, H. T.; Patterson, A.; Autler, S. H. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 55-6(June 1966).

33967 IRRADIATION GROWTH AND SWELLING ANALYSIS FOR FINITE CYLINDRICAL FUEL ELEMENTS. Ma, Benjamin M. (Iowa State Univ. of Science and Tech., Ames). Trans. Amer. Nucl. Soc., 9: 67(June 1966).

33968 EXPLORATION OF THE COMBINED EFFECTS OF ULTRA-HIGH PRESSURE AND NUCLEAR IRRADIATION ON SOLID-SOLID PHASE TRANSFORMATIONS. Kulcinski, Gerald LaVerne. Madison, Wis., Univ. of Wisconsin, 1966. 235p.

Thesis.

A special Bridgman opposed diamond anvil apparatus was constructed to generate useful static pressures up to 50 kbarr at ambient temperatures. It was designed to function in the environment of a nuclear reactor and occupied 4 in^3. While the bulk of this study deals with ZrO_2, other materials investigated to varying degrees were PbO_2, BN, B_2O_3, B, silicic acid, SiO_2, $BaTiO_3$, graphite, P, Ni, Zr, and U. The samples were exposed while under pressure to fast neutron fluxes (>1 Mev) of 8.2×10^{15} nvt. The boron-containing samples suffered up to 2×10^{18} fissions/cc while under pressure. PbO_2, BN, B_2O_3, silicic acid, graphite, SiO_2, and Zr were bombarded by uranium fission fragments to 6.5×10^{11}/cm^2 under pressure, while compressed ZrO_2 was exposed to 1.6×10^{14}/cm^2. There was no evidence of any irradiation-promoted phase change. Fluorescent analysis of ZrO_2 tetragonal-monoclinic mixtures was found to be valid for powders but not for thin films. It was found that pressure converts tetragonal ZrO_2 to the monoclinic form at room temperature. Pressure is also assumed to convert cubic ZrO_2 to the tetragonal + monoclinic forms. A PbO_2 I → II transformation is reported within seconds at room temperature. A pressure sensitive optical absorption edge for PbO_2 was found above 20 Kbarr. (Dissertation Abstr.)

33969 IRRADIATION EFFECTS ON CREEP RUPTURE AND FATIGUE STRENGTH OF PURE ALUMINUM. Zamrik, Sam Yusuf. University Park, Pa., Pennsylvania State Univ., 1965. 173p.

Thesis.

Neutron irradiation effects upon the following strength properties of annealed pure aluminum were studied: yield stress, ultimate stress, fatigue strength and stress rupture strength. Irradiated and unirradiated pure aluminum specimens were also subjected to a dynamic stress condition where an alternating stress was superimposed on a tensile mean stress. A stress analysis of the thermal recovery process in irradiated carbon steels was developed. The effect of temperature on the yield stress of irradiated carbon steels was discussed and analyzed. A theoretical correlation between a purely static stress rupture load and a dynamic stress load was obtained. In the experimental investigation, pure aluminum specimens 0.25 in. in diameter were irradiated to an integrated neutron flux of approximately 1×10^{18}nvt. Irradiated and unirradiated specimens were tested under various stress ratios, which varied from purely fatigue loading to purely stress rupture loading. Test results for all stress ratios were presented in the form of $\sigma - N$ diagrams and in a series of stress range diagrams showing the effect of neutron irradiation on pure aluminum. After an exposure to an integrated neutron flux of approximately 1×10^{18}nvt, the mechanical properties of annealed pure aluminum (99.993%) specimens were affected in the following manner: yield stress, significant increase; ultimate stress, slight increase or no change; ductility, slight decrease or no change; fatigue strength, significant increase; stress rupture, slight increase. Irradiated and unirradiated annealed pure aluminum specimens tested under dynamic stress showed a transition phase from ductile to brittle type failure. Experimental results are in good agreement with the theoretical correlation between a static stress rupture and a dynamic stress condition. (Dissertation Abstr.)

PHYSICS

General

Refer also to abstract 34872.

33970 (ORO-2915-61) THEORETICAL NUCLEAR PHYSICS PROGRESS REPORT, JUNE 30, 1965-JUNE 30, 1966. Rose, Morris E. (Virginia Univ., Charlottesville. Dept. of Physics). Contract AT(40-1)-2915. 24p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Brief summaries of research progress are given which fall into the following general areas: Nuclear structure, elementary particle physics, atomic physics, and weak interactions. (M.O.W.)

33971 TEST FIELD AND INFLUENCE FUNCTIONAL METHODS. Scalettar, R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Ann. Phys., (N. Y.), 38: 238-98(June 27, 1966).

Several general theorems concerning classical as well as quantum-mechanical multitime correlation functions are derived. The temporal behavior of these correlation functions for interacting systems is described exactly in terms of the response of the system to appropriately chosen external test fields, in the absence of interaction. A consequence of these results is a closed equation for the classical one-particle distribution function, which provides an alternative starting point for dealing with the B.B.G.K.Y. hierarchy of equations. A generalized form of the Feynman influence functional theorem is proved and, as an application, the field oscillators are eliminated and an exact effective interaction for a classical system of charged particles is determined in the Liouville picture. (auth)

33972 REPRESENTATION THEORY FOR CLASSICAL MECHANICS. Lugarini, G.; Pauri, M. (Univ., Parma, Italy). Ann. Phys. (N. Y.), 38: 299-314(June 27, 1966).

A representation theory for classical mechanics is proposed. It deals with the unitary group induced in the classical Hilbert space of Koopman and Von Neumann by the canonical realizations of a Lie group $\mathcal{G}$ of transformations. The concept of classical Lie algebra of $\mathcal{G}$ is defined by supplementing the usual commutation relations of its ordinary Lie algebra, with a set of commutation relations playing the role of supplementary conditions. Such conditions imply that the same infinitesimal generators of the canonical realizations of $\mathcal{G}$ are defined as additional operators in the classical Hilbert space and make possible the introduction of classical observables into the theory. The irreducible classical representations, i.e., the irreducible representations in the usual sense of the classical algebra, are classified. A selection of such classical representations leads to the characterization of all the irreducible representations which actually are the unitary counterpart of the canonical realizations of the group $\mathcal{G}$. They are called the canonical representations. The theory is applied to work out the canonical representations of the rotation group in three dimensions and of the Euclidean group of the plane. (auth)

33973 ENERGY OF A CHARGED PARTICLE. Mehra, A. L. (Univ. of Jodhpur, India). Curr. Sci. (India), 35: 304(June 20, 1966).

The total energy outside the charged particle of mass m and charge $4\pi\epsilon$ is obtained using Moeller's superpotential. (B.G.D.)

33974 A CaF_2Dy^{2+} OPTICAL MASER OPERATING WITH REPEATED GIANT PULSES AT CONTINUOUS PUMPING. Koniukhov, V. K.; Kostin, V. V.; Kulevskii, L. A.; Murina, T. M.; Prokhorov, A. M. Dokl. Akad. Nauk SSSR, 165: 1056-8(Dec. 11, 1965). (In Russian).

Following previous studies on the generation of giant pulses in $CaF_2:Dy^{2+}$ by means of a ruby laser, a repeating giant pulse was generated in the same material under conditions of continuous pumping with xenon lamps. A rotating prism was used for quality control. The Dy^{2+} concentration of the CaF_2 was about 10^{17} cm^{-3}; flowing supercooled liquid nitrogen was used to cool the crystal. A multilayer dielectric coating at the end of the cylindrical crystal served as one of the mirrors of the resonator while a quartz crystal with total internal reflection was used as the external mirror. The radiation was extracted from the resonator by means of a quartz lens at an incidence angle of 23° and was directed to a calorimeter and an InSb photodiode. The duration of the giant pulse was calculated as 105×10^{-9} sec, agreeing with experimental findings. The 2.36μ high-intensity, monochromatic source may be used for the two-photon excitation of semiconductors with a narrow forbidden zone. (TTT)

33975 NEW SOURCE OF POLARIZED NEGATIVE DEUTERIUM IONS. Cesati, A. (CISE, Milan); Cristofori, F.; Colli, L. Milazzo. Energ. Nucl. (Milan), 13: 328 (1966).

A brief description of a polarized negative deuterium ion source utilizing the two charge exchange process is presented. (B.G.D.)

33976 MICROWAVES BY CHERENKOV EFFECT. Jelley, J. V. IEEE (Inst. Elec. Electron. Eng.) Student J., 1: 2-9(July 1963).

The nature of Cherenkov radiation and its application to microwave generation are reviewed. Theoretical basis and instrumentation are presented. The Cherenkov generator, has inherent simplicity, does not require circuit structures which have dimensions comparable to the wavelength, is tuneable over a wide band, and will produce pencil-beam radiation patterns directly, without conventional antennas. While, for continuous media and uncorrelated electrons, the Cherenkov radiation appears in a wide spectral band, it can be concentrated into narrow bands by various means. The most important feature that a microwave Cherenkov radiator should possess is a high dielectric constant so that the threshold velocity shall be as low as possible. At the same time minimum absorption is also desirable. As an alternative to a pure dielectric, a microwave ferrite may be used for the slow-wave medium, the advantage being that the relative values of the real and imaginary parts of the magnetic permeability can be to some extent controlled by the application of an external d-c field. The main advantages of the Cherenkov technique are given. (TCO)

33977 NUMERICAL RESULTS FOR THE AUXILIARY EQUATION OF RADIATIVE TRANSFER. Bellman, R.; Kagiwada, H.; Kalaba, R. (RAND Corp., Santa Monica, Calif.). J. Quant. Spectros. Radiative Transfer, 6: 291-310(May-June 1966).

A basic problem in astrophysics, meteorology, and neutron transport theory is the determination of the internal intensity produced when uniform parallel rays illuminate a slab of finite thickness which both absorbs and scatters radiation isotropically. One approach to this problem is through the intermediate step of determining the source function which represents the rate of production of scattered radiation per unit volume per unit solid angle as a function of the depth below the top surface. Ordinarily this function is characterized as the solution of a singular integral equation, which presents difficulties from the numerical viewpoint. Other differential integral equations for the source function viewed as a function of the thickness of the slabs were previously derived. The results of extensive calculations of source functions in both graphical and tabular form are presented. (auth)

33978 PROOF OF THE IMPOSSIBILITY OF A CLASSICAL ACTION PRINCIPLE FOR MAGNETIC MONOPOLES AND CHARGES WITHOUT SUBSIDIARY CONDITIONS. Rosenbaum, David (Brandeis Univ., Waltham, Mass.). Phys. Rev., 147: 891-5(July 29, 1966).

A proof is given that no action principle exists for the

classical electromagnetic field when its sources are both charged particles and magnetic monopoles unless an extra condition, not derivable from the action principle, is assumed. The extra condition is that charges never touch magnetic monopoles. The Lorentz force law predicts that a charge and a magnetic monopole approaching each other along a straight line will collide. Since the Lorentz force law can only be gotten from an action principle with the aid of this extra condition, the necessary extra condition is in contradiction to the law derived with its help. Thus there is no satisfactory action principle for the classical electromagnetic field if both charges and magnetic monopoles exist. The foregoing provides an aesthetic argument against the existence of magnetic monopoles. An action principle has then been constructed using the extra condition. (auth)

33979 THE INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS, TRIESTE. pp 117-34 of STI/DOC-10/55.

Research on elementary particle physics and plasma physics is reviewed. (M.C.G.)

33980 FOLIATIONS AND THE DIRAC THEORY OF CONSTRAINTS [WITH] PART II: DIFFERENTIABLE MANIFOLDS. Hinds, George Libby. College Park, Md., Univ. of Maryland, 1965. 190p.

Thesis.

A model of the Dirac theory of constraints is investigated from the point of view of foliated manifolds. A treatment of distributions and foliations is given, and the equivalence of foliations to involutive distributions is shown. Horizontal, invariant, and baselike forms on a fiber manifold are defined, and the proposition is proved that an exterior form is baselike if and only if it is both invariant and horizontal. This classification of exterior forms is extended to foliated manifolds. Horizontal vector fields on a fiber manifold are treated, and the existence of horizontal lifts from the base is established. Next, a hamiltonian manifold is defined as a differentiable manifold with a closed, exterior 2-form ω, nondegenerate if this 2-form is nondegenerate, otherwise degenerate. Canonical transformations on a hamiltonian manifold are discussed in the nondegenerate case, and the Lie algebra of canonical vector fields is shown to be definable in terms of a Poisson bracket. A degenerate hamiltonian manifold is considered in the case when its 2-form ω has constant rank. Such a manifold carries the characteristic foliation of ω, and it is shown that this fact allows the manifold to be locally factored, the quotient being a nondegenerate hamiltonian manifold. Finally, a model problem is posed on a degenerate hamiltonian manifold, and an algorithm is developed for its solution, which embodies the principle features of the Dirac theory of constraints. (Dissertation Abstr.)

33981 OBSERVATIONS OF MAGNETICALLY SELF-FOCUSING ELECTRON STREAMS. Graybill, S. E.; Nablo, S. V. (Ion Physics Corp., Burlington, Mass.). 11p. (CONF-660107-30). ORAU. Gmelin, AED-CONF-66-003-56.

From American Physical Society Meeting, New York.

The self focusing of a partially neutralized relativistic electron beam in azimuthal magnetic fields is analyzed. (B.G.D.)

Accelerators

Refer also to abstracts 34724 and 34478.

33982 (BNL-10244) SHIELDING OF THE 200-Mev LINAC. Wheeler, G. W.; Moore, W. H. (Brookhaven National Lab., Upton, N. Y.). May 18, 1966. Contract AT(30-1)-Gen-16. 20p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The establishment of a rational and conservative set of criteria for beam loss in the 200-Mev linac injector for the AGS is discussed. These criteria are used to calculate shielding requirements. Consideration is given to the effect of penetrations in the shielding, to activation of the linac components, and to methods of control and monitoring of the radiation. (B.G.D.)

33983 (BNL-10245) INVESTIGATION OF BEAM TRANSPORT MAGNET COIL FAILURES. Allinger, J. E. (Brookhaven National Lab., Upton, N. Y.) Feb. 18, 1966. Contract AT(30-1)-Gen-16. 5p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A review is presented of the history of the AGS beam transport coils. Twenty-five magnet coil failures are reported to have occurred in the beam transport magnet coils since June, 1962. An investigation was made of these failures. The results are discussed. (M.O.W.)

33984 (JINR-P-2693) VYVOD PUCHKA TYAZHELYKH IONOV IZ 310-SM TSIKLOTRONA OIYAI. (Extraction of a Heavy Ion Beam from the 310-cm Cyclotron of the Joint Institute for Nuclear Research). Alfeev, V. S.; Vyalov, G. N.; Linev, A. F.; Pokrovskii, V. I.; Savelev, V. A.; Titov, V. N.; Chugreev, V. A.; Shelaev, I. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 18p. Dep. mn.

An extraction system for a heavy ion beam of 310 cm classical cyclotron is described. It consists of an electrostatic deflector with a hyperbolic profile and of horizontally-focusing magnetic channel. The extraction coefficient was found to be about 50%. The dimension of the extracted beam at the removed target is not greater than 1 cm^2, the monochromaticity being not worse than 1.5%. (auth)

33985 (MURA-700) STUDY OF A 500-Mev HIGH-INTENSITY INJECTOR. Snowdon, S. C. (Midwestern Universities Research Association, Stoughton, Wis.). Sept. 8, 1964. Contract AT(11-1)-384. 76p. Dep. mn. CFSTI $1.75 cy, $0.75 mn.

A design study is presented for a 500 Mev FFAG accelerator capable of producing 10^{14} protons per second. A 20 Mev linac is used to inject 0.83×10^{12} protons 120 times per second into the accelerator. If desired, up to 16 pulses may be stacked at 500 Mev thereby yielding 1.33×10^{13} protons per ejected pulse. The study also includes a cost analysis. (auth)

33986 (N-65-32092) A PRELIMINARY DESIGN STUDY OF A MICROPARTICLE ACCELERATOR. Final Report, January 30-April 13, 1964. Arnold, K. W.; Britton, R. B.; Cheever, R. N.; Denholm, A. S.; Nablo, S. V. (Ion Physics Corp., Burlington, Mass.). [1964]. Contract NAS2-1873. 64p. (NASA-CR-56191). CFSTI $3.00 cy, $0.75 mn.

The preliminary design considerations for a proposed 2 Mv microparticle accelerator are discussed. The primary objectives in the study were the attainment of minimum particle path length, very low environmental pressure (~10^{-8} torr), accommodation to a possible 10% particle charge loss in flight, and a capability of future extrapolation to higher voltages in a machine having both the particle source and target assembly at ground potential. The design which has evolved is a four-stage device in which the particle is sequentially accelerated into drift tubes at 500 kv negative potential which are then switched to ground while the particle is shielded inside. A complete description of the accelerator and the method of installation on the proposed site as well as descriptions and specifications of component parts is provided. (auth)

33987 (N-65-32096) A PRELIMINARY DESIGN STUDY OF A MICROPARTICLE ACCELERATOR. Final Report, April 14-July 6, 1964. Arnold, K. W.; Cheever, R. N.; Denholm, A. S.; Elcox, R. E.; Lavelle, J. E. (Ion Physics Corp., Burlington, Mass.). [1964]. Contract NAS2-1873. 30p. (NASA-CR-58647). CFSTI $2.00 cy, $0.50 mn.

Design considerations, drawings, and circuit diagrams for a single stage prototype microparticle accelerator are presented. Qualification tests are also described which will assess the reliability of the system and its components and confirm that they operate according to specifications. (auth)

33988 (ORNL-P-2262) RESEARCH WITH AVF CYCLOTRONS IN THE USA. Bassel, R. H. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 13p. (CONF-660510-9). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Conference on Isochronous Cyclotrons, Gatlinburg, Tenn.

A brief survey was made of the experimental uses of AVF cyclotrons. The results of the survey are presented. (M.O.W.)

33989 (UCRL-16727) INFLUENCE OF CYCLOTRON BEAM PROPERTIES ON EXPERIMENTS. Conzett, H. E. (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 1966. Contract W-7405-eng-48. 14p. (CONF-660510-11). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Conference on Isochronous Cyclotrons, Gatlinburg, Tenn.

The importance and relationship of cyclotron beam characteristics to various experiments are discussed, and examples of some of the influences are given. The beam properties considered include phase-space density, energy, energy-spread, energy-variability, energy stability, and duty factor. (auth)

33990 (UCRL-16882) MODIFICATION STUDIES FOR THE BERKELEY 184-IN. CYCLOTRON. Clark, D. J.; Kim, Hogil; MacKenzie, K. R.; Vale, J. T. (Lawrence Radiation Lab., Univ. of California, Berkeley). May 1966. Contract W-7405-eng-48. 17p. (CONF-660510-12). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Conference on Isochronous Cyclotrons, Gatlinburg, Tenn.

Studies are in progress on possible improvements to the center region and extraction system of the 184-in. cyclotron. The center region is being studied with a 28-in. model proton cyclotron. It has been operated without frequency modulation at 16 kG and 23 kG at 1% duty cycle. Frequency modulation has now been added to study space charge and capture problems. Computer studies are also being done with an orbit code including electric field, to study median plane motion. The extraction system is being examined to reduce losses in the regenerator region. (auth)

33991 SOME RESULTS OF COMPUTATIONS FOR INCLINED-FIELD ACCELERATION TUBES. Koltay, E.; Dvarmati, B. ATOMKI (Atommag Kut. Intez.) Kozlem., Mellek., 8: 17-22(1966). (In Russian).

Data obtained from numerical computations on the electron-optical properties of prismatic sectors used in inclined-field acceleration tubes are presented. (auth)

33992 STABILIZATION OF THE CYCLOTRON DEFLECTOR VOLTAGE. Fukatko, T. (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Kernenergie, 9: 122-4(Apr. 1966). (In German).

A voltage stabilizer for the deflector of a cyclotron is described. (D.C.W.)

33993 EXTRACTION OF ELECTRON BEAM FROM A BETATRON. Toriyama, Hideaki; Hattori, Hiroyuki (Shimazu Seisakusho, Ltd., Japan). Oyo Butsuri, 35: 245-50(Apr. 1966). (In Japanese).

The x-ray output of a betatron is decreased by $\frac{1}{2} \sim \frac{1}{3}$ by placing a peeler of ferro-magnetic material in the donut; because the peeler disturbs the magnetic field on the electronic orbit, and many electrons strike it and get lost before they are accelerated. But, by placing a peeler very close to the outside wall of the donut, much more x radiation is obtained. The peeler used is a pipe of Fe–Cr alloy which is easily supported. For producing electron beams, the orbit is expanded outward and at the same time shifted toward the peeler, so that most electrons clear the electron gun and enter the opening of the peeler. A dose-rate of 24 Mev electrons 1000 R/min at 1 m from the center line of the magnet is obtained. (auth)

33994 CONTROL, STABILIZATION, AND ENERGY CALIBRATION OF THE BETATRON AT THE INSTITUTE OF ATOMIC PHYSICS. Baciu, G.; Catana, D.; Deberth, C.; Raileanu, I. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 11: 153-64(1966). (In French).

For studying the photonuclear reactions induced by betatron gamma-ray beams, it is necessary to define with a good approximation the end energy of the bremsstrahlung spectrum. A method of betatron energy control based on the magnetic flux measurement is analyzed. A logic interpretation and evaluation of inherent errors is made. The calibration of the energy scale within the limits ±65 Kev is made through the well known threshold of photoneutron reactions in Cu, F and C. The results of short and long time stability verification of the system are also included. (auth)

33995 EXTENSION OF ENERGY RANGE FOR PROTONS UP TO 12.50 Mev IN THE IAP U-120 CYCLOTRON. Macovei, M.; Moteca, P.; Papureanu, S.; Popescu, C.; Andruscenco, P. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 11: 171-8(1966).

The main parameters influencing proton production, acceleration and extraction are analyzed, and experimental results concerning proton acceleration from 5.0 to 12.50 Mev/nucl in the IAP U-120 cyclotron are given. The possibility of using the magnetic shimming for correcting the magnetic field in a large range of magnetic inductions is analyzed. (auth)

33996 ACCELERATORS WITH COLLIDING PARTICLE BEAMS. Budker, G. I. Vestn. Akad. Nauk SSSR, No. 4, 30-43(Apr. 1966). (In Russian).

The general characteristics of particle accelerators with colliding beams are discussed. The main advantage of colliding beams is the higher collision energies available at a reasonable cost. A Siberian accelerator (BEP-1) is described. It has a radius of 43 cm and accepts 43-Mev electrons from an iron-free synchrotron. The current is about 300 ma (greater than 10^{10} particles) with a duration of less than 5 nanoseconds. The energy dispersion does not exceed 0.2%. The control system is described. The beam can be observed visually. Electron currents up to 0.5 amp can be accumulated, but only 50 mamp is used in practice. A number of electron scattering experiments are described. Electron-positron accumulators are being designed at energies of 2×5 Bev. (TTT)

33997 ACHROMATIC DEFLECTION AND ANALYZING SYSTEM FOR DIVERGENT RADIATION BEAMS FROM CIRCULAR ACCELERATORS. Jung, Volkhard; Trier, Jost Otto; Feist, Harald (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Angew. Phys., 20: 533-5(1966). (In German).

Using a system with mirror symmetry consisting of 3 magnetic sector fields with the deflecting angle of the interior sector being smaller than that of the exterior ones it is possible to fulfill the following conditions for analyzing divergent beams from circular accelerators: achromatic imaging of the source, vanishing angular dispersion at the image point and simultaneous energy selection in a chromatic intermediate image. The matrices for chromatic intermediate-imaging and achromatic final-imaging are deduced. From the matrix elements relations between the sector angles and the linear dimensions of the system are derived. (auth)

33998 MEASURING ARRANGEMENT FOR DETERMINING THE LIFETIME OF MAGNETICALLY FOCUSED ELECTRON BEAMS. Bundke, Werner (Univ., Frankfurt am Main). Z. Angew. Phys., 20: 550-4(1966). (In German).

An apparatus for measuring the lifetime of a magnetically focused electron beam is described. After an explanation of the chosen principle of measurement, the function of the individual parts of the apparatus is dealt with. (auth)

33999 FOCUSING OF SMALL PARTICLES BY AXIALLY SYMMETRIC ELECTROSTATIC FIELDS. Shtepa, N. I. (Chernigov Pedagogical Inst., USSR). Zh. Tekh. Fiz., 36: 470-81(Mar. 1966). (In Russian).

The focusing by axially symmetric electrostatic fields of homogeneous isotropic spherical charged or neutral particles moving in vacuum or in a viscous medium are discussed in detail. The particles are assumed to be small compared with the distance within which the fo-

cusing field changes significantly and large enough for their Brownian motions to be neglected; particle diameters in the range from 1 to 1000 microns are contemplated. The equations of motion of such particles in an axially symmetric electrostatic field are written with not only the Coulomb force on the particle included, but also the force due to polarization of the particle in the electric field, the Stokes force due to the viscosity of the medium, and the force of gravity. The axis of the system is assumed to be vertical. The solutions of the equations of motion are discussed at length with particular attention to the focusing and imaging qualities of thin lenses. Particular cases in which one or more of the enumerated forces is negligible are discussed separately. It is shown, for example, that the focal length of an electrostatic lens is always negative in the case of neutral weightless particles. Beam convergence and formation of real images can be obtained in other cases, however. Thin lenses are very inefficient when the viscous forces are large and in this case it would be advantageous to employ thick lenses. It is believed that the calculations can be of practical use in the technology of handling streams of small particles. (ATD)

34000 LONGITUDINAL INSTABILITY OF A PARTICLE CLUSTER IN A CYCLIC ACCELERATOR. Grigor'ev, V. P. Zh. Tekh. Fiz., 36: 482-5(Mar. 1966). (In Russian).

The longitudinal instability associated with the Cherenkov interaction mechanism of a cluster of accelerated particles in a coaxial accelerator in the presence of the h-f accelerating field is discussed. The calculations are based on the kinetic equation for small deviations from the equilibrium value of the function representing the distribution of the accelerated particles with respect to longitudinal velocity and phase. The transverse velocities of the particles are neglected. The interaction of the particles with the accelerating field and with the normal modes of the accelerator cavity is taken into account in the kinetic equation, and the dispersion equation that governs the behavior of small density fluctuations is derived. The dispersion equation was solved numerically for particular values of the parameters and a particular unperturbed distribution function. This solution is presented graphically and the behavior of the solution for other parameter values is discussed briefly. There is a range of frequencies within which unstable oscillations occur. The region of instability increases with decreasing Q of the accelerator cavity, increasing number of particles in the cluster, and decreasing accelerating field strength. (ATD)

34001 CONCERNING CAPTURE OF ELECTRONS IN A BETATRON. Tulinova, N. I. Zh. Tekh. Fiz., 36: 486-90(Mar. 1966). (In Russian).

Earlier work on capture of electrons in a betatron orbit is continued. The experiments were performed with the 3-Mev betatron of ordinary design. The radii of the inner and outer walls of the betatron and of the equilibrium orbit were 4.5, 10.5, and 7.5 cm, respectively. Injection was initiated at a stage in the cycle when the instantaneous orbits would be close to the equilibrium orbit and was continued for different lengths of time ranging from 1 to 14 periods of revolution of an electron in the betatron. The injection current was varied from 1 to 43 mamp and the potential on the injector was varied from 0.5 to 1.75 kv. The resulting gamma intensity, regarded as a measure of the number of captured electrons, is presented graphically as a function of the duration of injection for different fixed values of the injector voltage and injection current. These curves have maxima (or in two cases exhibit onset of saturation) at an injection time of about 5 betatron revolution periods. The curves for the higher values of the injection current have the sharper maxima. The observed behavior is ascribed to the effect of interaction between successive turns of the injected beam. It is shown that such interaction can either enhance or damp out betatron oscillations and, with the aid of earlier results, that in the present betatron such interaction will result in loss of all but the last two or three turns of the injected beam. A theoretical curve of gamma intensity as a function of injection time based on these calculations would show onset of saturation at an injection time of 2 or 3 betatron revolution periods. By taking into account the angular spread of the injected beam, however, which in the present experiments was ±6°, it was possible to derive theoretical curves with maxima at the injection time of 5 revolution periods, as observed. It is concluded that interaction between successive turns of the injected beam plays a significant role in the capture of electrons in betatrons. (ATD)

34002 VACUUM SYSTEM FOR ACCELERATING TUBES. Peter, Karl Heinz (to Leybold Hochvakuum-Anlagen GmbH). German Patent 1,214,342. Apr. 14, 1966. Filed Nov. 11, 1963.

The effective pumping speed of the high vacuum pumps, which are connected to the earthed end of the accelerating tube, is at least the fivefold of the reciprocal of the flow resistance of the tube. (Gmelin Inst.)

34003 HIGH ENERGY ACCELERATOR MAGNET STRUCTURE. Gordon, Hayden S. (to U. S. Atomic Energy Commission). U. S. Patent 3,263,136. July 26, 1966.

Alternating gradient electromagnets which establish a curving beam orbit in certain forms of charged particle accelerator are considered. Portions of the magnet winding are disposed along each side of the gap formed by the magnet poles. Each turn of coil conductor has a curving cross-sectional shape conforming with the desired field configuration thereat and has a cross-sectional area related to the desired localized field intensity. This forces a preferred field configuration at the sides of the gap and therefore results in a more optimized field throughout the gap. A higher field at the beam orbit and a broader usable gap result while pole and coil bulk may be reduced. (AEC)

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Refer also to abstracts 34386, 34390, 34397, 34406, 34412, 34674, 34742, 34770, and 34781.

34004 (AD–627686, pp 25-38) SOLAR FLARES AND PREDICTION. Firor, John; Lilliequist, Carl (High Altitude Observatory, Boulder, Colo.).

Those aspects of solar flare observation and theory that are relevant to the prediction of solar flares are reviewed. It is pointed out that several observable quantities have been isolated and correlated with observed flare activity and are now ready to be tested in actual prediction programs. These quantities include the magnetic structure of active regions, the areas of sunspot penumbras, the line of sight velocities of limb regions, the occurrence of flares, and meteorological data. Problems in the prediction of solar flares are discussed. (23 references.) (C.H.)

34005 (CNIE-PT-4) EVOLUTION OF AN HOMOGENEOUS SPHERICAL GAS. Cernuschi, F.; Marsicano, F. R. (Comision Nacional de Investigaciones Espaciales, Buenos Aires (Argentina)). 1965. 16p. Dep. mn.

Some possible processes of expansion of a gaseous stellar mass are studied. It is assumed that the spherical form and a uniform distribution of the mass are maintained, the perfect gas law is applicable, that the total mass is kept constant, and that the evolution is adiabatic. By applying the virial theorem, a differential equation is obtained which permits analysis of different types of expansion processes. The conditions for limited expansions, of the considered spherical gaseous mass, are deduced for the cases when the radiation pressure is negligible, the corpuscular pressure is negligible in front of the radiation pressure, and when both pressures are taken into account. The case when there exists a uniform magnetic field proportional to $\rho^{1/2}$ is also studied. (auth)

34006 (N–66–10681) ON THE FLOW OF A MAGNETIZED SOLAR WIND AROUND THE MOON. Jokipii, J. R. (RAND Corp., Santa Monica, Calif.). Sept. 1965. Contract NASr-21. 13p. (NASA-CR–67820; RM–4714-NASA). CFSTI $1.00 cy, $0.50 mn.

The effects of interplanetary magnetic fields on the flow of plasma around the moon are considered. If the moon possesses a negligible magnetic field, and if the conductivity of the moon is not appreciably less than 10^6 sec^{-1} in Gaussian units, a crude analysis indicates that most of the solar wind is deflected around the moon and only a small fraction actually strikes the lunar surface. Consequences for recent models of the lunar atmosphere are briefly discussed. (auth)

34007 (N-66-12863) A HIGH-ALTITUDE MEASUREMENT TO DETERMINE THE RATIO OF DEUTERIUM TO HYDROGEN IN THE SOLAR ATMOSPHERE. Quarterly Status Report, June 1-August 31, 1965. Henderson, Gordon (IIT Research Inst., Chicago, Ill.). Oct. 21, 1965. Contract NASr-65-(13). 12p. (NASA-CR-68240; IITRI-A6141-QR1). CFSTI $1.00 cy, $0.50 mn.

The off-band suppression available with various combinations of Fabry-Perot interferometers and forefilters is under study and has resulted in a decision to design the system to comprise: a 10A halfwidth forefilter centered on H_α at 6562.8A; a scanning Fabry-Perot interferometer of 6A free spectral range and a finesse of 30, giving a resolution of 0.2A; and a second scanning Fabry-Perot interferometer of 13.75A free spectral range and a finesse of 30, giving a resolution of 0.46A. When the instrumental function of the combination is combined with the narrow pass forefilter the result is the overall transmission of the complete system. An outline of the system to accurately measure the transmission function of the forefilter is shown. (STAR)

34008 (N-66-12966) PROTONS AND HELIUM NUCLEI WITHIN INTERPLANETARY MAGNETIC REGIONS WHICH CO-ROTATE WITH THE SUN. Fan, C. Y.; Gloeckler, G.; Simpson, J. A. (Enrico Fermi Inst. for Nuclear Studies, Univ. of Chicago, Ill.). [1965]. Contracts NAS5-2990; NAS5-2133; AF19(628)-2473. 16p. (NASA-CR-68314; EFINS-65-89). CFSTI $1.00 cy, $0.50 mn.

It was shown from IMP-I measurements in 1964 that fluxes of protons of >1 Mev energy appeared for several days in a sequence of six consecutive 27-day intervals. It was concluded that these protons were confined within a region corotating with the sun which modulates the galactic cosmic radiation at the orbit of Earth with the same 27-day recurrence period. This region has persisted for more than 20 solar rotations and was observed with the IMP-I magnetometer by Ness and Wilcox to possess special characteristics. The energy spectrum of the protons in the leading and trailing sides of the corotating region was measured. A helium component continuously associated with the protons was found with an energy spectrum of E^{-2} Mev/nucleon in the energy range 2 to 30 Mev/nucleon. Evidence from the OGO-I satellite indicates that the proton and helium fluxes are not only present within corotating regions, but are also present at lower intensity and with different spectra at all times throughout a 2.5 month period. The source for continual acceleration of these protons and helium nuclei is discussed. (auth)

34009 (N-66-16405) ANALYSIS OF DESIGN CRITERIA FOR A RADIO-FREQUENCY PROTON EVENT WARNING SYSTEM OPERATING IN THE FREQUENCY RANGE 1000-3750 MEGACYCLES PER SECOND. Shlanta, Alexis; McAnally, Michael D. (Texas Western Coll., El Paso. Schellenger Research Labs.). Sept. 1965. 50p. (NASA-CR-69853). CFSTI $2.00 cy, $0.50 mn.

A statistical analysis was made on solar radio emission associated with large proton events and solar radio outbursts associated with no proton events and small proton events for the frequency range 1.0-3.75 Gc/s. Specific criteria were established for this frequency range. Furthermore, investigations were made into false alarms and frequency combinations. The results of this analysis can serve as the basic design criteria for an electronic system that may provide a warning for large solar proton events. This criteria will hold for any frequency in the range 1.0-3.75 Gc/s. Such a warning system would reduce the corpuscular radiation hazard to future space flights. (auth)

34010 OPTICAL POSITIONS FOR RADIO SOURCES IN THE 3C REVISED CATALOGUE. Veron, P. (California Inst. of Tech., Pasadena). Astrophys. J., 144: 861-5 (June 1966).

The optical positions of seventy-three galaxies and four quasi-stellar sources identified with radio sources in the 3C revised catalogue are given with an accuracy of about 1″ in both coordinates. The positions of objects in the field of fifty-four radio sources are also given so as to facilitate the eventual positive identifications of these radio objects. (auth)

34011 UPPER LIMIT ON THE BINDING ENERGY OF A MAGNETOTURBULENT SUPERMASSIVE STAR. Bardeen, James M.; Anand, S. P. S. (California Inst. of Tech., Pasadena). Contract [Nonr-220(47)]. Astrophys. J., 144: 953-8 (June 1966).

The argument that a magnetic field can suppress the degradation of turbulence in a star must break down when the mean turbulent velocity exceeds the speed of sound of the gas. The resulting upper limit on the ratio of turbulent kinetic energy to thermal internal energy is applied in the post-Newtonian binding energy formula to give upper limits of 0.0014 on the fractional binding energy E_b/Mc^2 of a non-rotating magnetoturbulent supermassive star and of 1.3×10^8 $M_\odot$ for the mass which can reach radiative equilibrium under the CNO bi-cycle through Kelvin-Helmholtz contraction. These upper limits are considerably lower than those of Pacholczyk and Anand. The role of rotation in the production of magnetoturbulence is discussed briefly, and it is shown that rotation cannot modify the upper limits significantly. (auth)

34012 SEMICONVECTIVE ZONE IN VERY MASSIVE STARS. Stothers, Richard (Goddard Space Flight Center, New York). Astrophys. J., 144: 959-67 (June 1966).

Models are constructed for very massive stars in the range 45-1000 $M_\odot$ during hydrogen burning in order to examine the role of convective instability. The semiconvective zone shows a maximum growth (in mass fraction) at about 60 $M_\odot$, with a chosen initial hydrogen abundance of X = 0.70. Sixty solar masses are also the maximum mass found by Schwarzschild and Härm to be stable against radial pulsations for nearly the same chemical composition. Radiation pressure has a critical destabilizing influence here. In the limit of the highest masses, the semiconvective zone disappears toward the surface, but the star still evolves inhomogeneously. It is shown that asymptotic limits at core-hydrogen exhaustion exist for the mass fraction of the convective core, the mean hydrogen content, and the hydrogen-burning lifetime. (auth)

34013 STELLAR FORMATION RATES IN YOUNG CLUSTERS. Iben, Icko Jr.; Talbot, Raymond J. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 144: 968-77 (June 1966).

Theoretical time-constant loci appropriate to clusters in which most members are still contracting toward the main sequence are presented and compared with the position in the theoretical H-R diagram of stars in NGC 2264 and NGC 6530. The relative merits of the hypothesis that all stars in a given cluster are formed simultaneously and of the hypothesis that stellar formation occurs continuously are examined. It is shown that, on the hypothesis of continuous formation, the total stellar formation rate increases exponentially with time following the formation of the oldest cluster members and that the average mass of the stars formed in any given time interval also increases exponentially with time. Finally, it is shown that the formation rate of intermediate mass stars rises to a maximum and then decreases as more massive stars are formed in significant numbers. (auth)

34014 ON THE NATURE OF THE HORIZONTAL BRANCH. I. Faulkner, John (California Inst. of Tech., Pasadena). Astrophys. J., 144: 978-94 (June 1966).

The correlation of certain horizontal-branch characteristics with observed metal abundance is discussed, and the hypothesis that stars survive the helium flash without mixing is reexamined. It is shown that metal content, particularly as it affects the strength of a hydrogen-burning shell,

controls the structure of a double-energy-source model, leading qualitatively to the observed correlation. Models are constructed for two values of the envelope helium content, 10 and 35% by mass. Quantitative agreement at present suggests a preference for the latter figure, which may have cosmological or cosmogonical significance. (auth)

34015 THE EVOLUTION OF POPULATION II STARS. Faulkner, J. (California Inst. of Tech., Pasadena); Iben, Icko Jr. Astrophys. J., 144: 995-1000 (June 1966).

On comparing the evolutionary paths of several double energy-source models with the horizontal branch in metal-weak Population II clusters such as M92, it is found that best fits are achieved with stellar masses $M_s \sim 0.70\ M_\odot$, CNO content $Z_{CNO} \sim 10^{-4}$, and with two choices of envelope hydrogen content, $X_e \cong 0.65$ or $X_e \cong 0.90$. Models with $X_e \cong 0.65$ evolve along the horizontal branch for $\sim 1.3 \times 10^8$ years compared with $\sim 4 \times 10^7$ years for models with $X_e \cong 0.90$, a result which favors the choice $X_e = 0.65$. Evolutionary tracks corresponding to hydrogen-burning stages off the main sequence show that it is possible to achieve good fits with the subgiant and giant branches of M92 for $X_e = 0.65$, $Z_{CNO} = 10^{-4}$. With this composition, masses of stars along the giant branch are found to be $\sim 0.70\ M_\odot$. Thus, by choosing for Population II stars an initial helium abundance usually attributed only to Population I stars, it is possible to account for several features of the horizontal branch without assuming significant mass loss between the red-giant and horizontal-branch stages. Further, satisfactory fits with the characteristic shape of the subgiant and giant portions of globular clusters are readily achieved, and cluster ages are more consistent with the Hubble time than is the case with the higher choice of X_e. (auth)

34016 HELIUM SHELL-BURNING STARS OF LOW MASS WITH PURE HELIUM ENVELOPES. Rose, William K. (Princeton Univ. Observatory, N. J.). Astrophys. J., 144: 1001-7 (June 1966).

Equilibrium models of helium shell-burning stars with pure helium envelopes are described. Eighty-five models are computed. The values for the mass range from 0.36 to $0.75\ M_\odot$ and the values for q, the mass fraction inside the core, range from q = 0.3 to q = 0.987. Three main results arise: one can estimate the lowest mass that is possible for helium burning as a function of q; as q increases (i.e., as the evolution of the star advances) a critical value is reached beyond which the entire star contracts; and there exists a value of q such that the luminosity is a maximum. The evolutionary tracks of subsequent models are found to be similar to those observed for the nuclei of planetary nebulae. (auth)

34017 STELLAR ROTATION AND STELLAR EVOLUTION AMONG CEPHEIDS AND OTHER LUMINOUS STARS IN THE HERTZSPRUNG GAP. Kraft, Robert P. (California Inst. of Tech., Pasadena). Astrophys. J., 144: 1008-15 (June 1966).

The calculation of evolutionary tracks through the Hertzsprung Gap by Iben and by Kippenhahn and his associates permits a comparison between theory and observation in a number of respects. Based on this comparison, the following proposals are advanced: the population of stars in the Hertzsprung Gap per unit volume of space can be reasonably accounted for by the tracks; the decline in the frequency function for classical Cepheids of short period can be explained; the line profiles of all Cepheids and supergiants brighter than MK class II are a result of macroturbulence, not rotation, even for stars of types as early as A and F; and among classical Cepheids rotation and pulsation are observationally incompatible phenomena because Cepheids descend from nonvariables of very slow rotation. (auth)

34018 SOLAR EVOLUTION AND BRANS-DICKE COSMOLOGY. Roeder, R. C.; Demarque, P. R. (Univ. of Toronto). Astrophys. J., 144: 1016-23 (June 1966).

The evolution of the Sun from the zero-age main sequence was studied using the assumption that the gravitational constant, G, is time-dependent and is given by the flat-space solution of the Brans-Dicke theory. The effects of the choice of the parameters ω and H upon the evolutionary track are shown. It is concluded that a good fit to the present Sun in terms of M_{bol} and $\log T_{eff}$ can be found for reasonable choices of the above parameters and chemical composition. The results obtained here also imply that the neutrino flux from the Sun could be appreciably different from that predicted by Ezer and Cameron without conflicting with the Brans-Dicke theory. (auth)

34019 TIME-DEPENDENT METHOD FOR COMPUTATION OF RADIATION DIFFUSION AND HYDRODYNAMICS. Cox, Arthur N.; Brownlee, Robert R.; Eilers, Donald D. (Los Alamos Scientific Lab., N. Mex.). Astrophys. J., 144: 1024-37 (June 1966). (LA-DC-7366).

A one-space-dimension, energy-flow computing method for use on high-speed electronic data-processing machines is described. The procedure allows one to follow, for many points of fixed mass, the time variations of temperature, density, pressure, and other material properties due to the flow of energy by radiation, conduction, convection, and by hydrodynamic processes. Detailed data on equations of state, opacity, conductivity, and energy generation can be used in conjunction with the energy-flow equations. The techniques described are applicable to problems of stellar interiors ranging from stellar pulsation to static stellar models and their evolution. (auth)

34020 SELF-EXCITED RADIAL OSCILLATIONS IN THIN STELLAR ENVELOPES. I. Cox, J. P. (Univ. of Colorado, Boulder); Cox, A. N.; Olsen, K. H.; King, D. S.; Eilers, D. D. Contract DA-31-124-ARO-(D)-139. Astrophys. J., 144: 1038-68 (June 1966). (LA-DC-7367).

The computation techniques described in the previous paper by Cox, Brownlee, and Eilers were used to study self-excited radial pulsations in stellar-envelope models and the basic physics of the destabilizing mechanism arising from He^+ ionization in the envelopes. The mass of the envelope is about 10^{-4} of the total stellar mass (= 5.395 $M_\odot$ for all models) and the envelopes consist of either twenty or fifty mass zones. The temperature at the bottom of the envelopes is about 10^{5}K, high enough so that the envelopes contain the entire He^+ ionization region plus enough material below to provide considerable radiative damping. The lower boundaries of the envelopes are held fixed in time (at a radius typically 0.8–0.9 of the total stellar radius), and a constant luminosity is fed into the envelopes from below. The envelopes are followed in time from an initial state which is in very close hydrostatic and thermal equilibrium. Unstable envelopes develop radial pulsations whose amplitude grows exponentially to some limiting amplitude in several hundred periods, whereas stable envelopes remain in equilibrium. The pulsations are practically periodic at limiting amplitude, and their properties are independent of the method of reaching the limiting amplitude. Most of the unstable envelopes studied (about 11) had $\delta R/R_0$ (radius semi-amplitude) $\simeq 0.04-0.05$, total surface velocity amplitude $\simeq 60-70$ km/sec, and total bolometric light range $\sim 0.3-0.4$ mag at limiting amplitude. The relative smallness of the radial variations at limiting amplitude suggests that the limiting amplitude is determined primarily by a saturation effect of the driving mechanism. The results show that the opacity variations (the κ-mechanism of Baker and Kippenhahn) and the small values of $\Gamma_3 - 1$ in the He^+ ionization zone both produce negative dissipation in and above the region. Evidence is also found for the existence of negative dissipation in the H ionization region, but this negative dissipation is swamped by other effects. The negative dissipation in and above the He^+ ionization region and the positive dissipation below are approximately equal at limiting amplitude. Two envelope instability strips, corresponding to two chemical compositions (a pure He/H mix and an Aller mix) and two mass-luminosity laws, are found on the Hertzsprung-Russell diagram close to the region of the classical Cepheids. If our periods were corrected for the shallowness of our envelopes, our computed instability strips for the fundamental mode of the whole star would be shifted toward

lower effective temperatures (by about $\Delta \log T_e \simeq 0.036$) and would then lie slightly to the right of the center of the Cepheid strip. Some suggestions are offered concerning some of the factors that may determine the upper and lower boundaries of the Cepheid instability strip. (auth)

34021 SELF-EXCITED RADIAL OSCILLATIONS IN THIN STELLAR ENVELOPES. II. King, D. S. (Indiana Univ., Bloomington); Cox, J. P.; Eilers, D. D. Contract DA-31-124ARO(D-139). Astrophys. J., 144: 1069-72 (June 1966).

The procedures described previously (Cox, et al., J. A., 144: 1024(1966)) were used to extend the study of shallow-envelope models of stars in the Cepheid region of the Hertzsprung-Russell diagram. Two new sequences of models have been obtained. One of these has a luminosity one-third that of the Aller mix (Group III) models. The other sequence has a luminosity twelve times that of Group III. Three unstable models in each of the two sequences were followed to limiting amplitude. The pulsation properties of these models are given. The position and the slope of the theoretical instability strip, as given by these models, are discussed. A variation of the limiting amplitude with horizontal position in the strip is found, with the amplitude being largest near the center of the strip. (auth)

34022 LIMB DARKENING FOR A GRID OF MODEL STELLAR ATMOSPHERES. Gingerich, Owen (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J., 144: 1213-15(June 1966).

Monochromatic limb-darkening predictions with several wavelengths and a sequence of μ-values are tabulated for a series of model atmospheres ranging from $T_{eff} = 10000$ to 7000°K, the ratio He/H by number is 0.2 in all cases. All models are computed for radiative equilibrium and contain absorption from neutral hydrogen, H^-, H_2^+, Rayleigh scattering, and continuous absorption from Si and Mg; the 9000 to 10000°K models include absorption from overlapping wings of the hydrogen Balmer lines as well. (B.G.D.)

34023 THE PHOTOMETRIC PROPERTIES OF MERCURY. Sagan, Carl (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 144: 1218-21(June 1966).

An attempt is made to attribute the photometric properties to the same cause as the lunar photometric properties. The possible sources considered are the kev solar proton wind, solar cosmic rays, and accretion of interplanetary dusts. (B.G.D.)

34024 CONSEQUENCES OF THE TORQUE EXERTED ON THE SUN BY THE SOLAR WIND. Brandt, John C. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 144: 1221-2(June 1966).

The analysis of the distribution of angular momentum between the Sun and the planets, which can be explained by the solar wind, leads to a direct determined value of 9 ± 3 km/sec for the mean azimuthal velocity of the solar wind plasma at the orbit of the Earth in the direction of the solar rotation. Two hypotheses on the state of the solar interior resulting from this analysis are discussed. These are that the Sun rotates essentially as a solid body and that the Sun has a rapidly rotating core (period ~1 day) and a slowly rotating atmosphere that is braked by the solar wind. (B.G.D.)

34025 RADIO AND OPTICAL DATA ON FIFTEEN QUASI-STELLAR OBJECTS. Bolton, J. G.; Shimmins, A. J.; Ekers, J.; Kinman, T. D.; Lamla, E.; Wirtanen, C. A. (CISRO, Sydney. Univ. of California, Mount Hamilton). Astrophys. J., 144: 1229-32(June 1966).

Confirmation for fifteen quasistellar objects (QSO's) are obtained from a comparison of the position measurements of high precision made with the Parkes telescope and optical positions measured at Lick Observatory. Finding charts for these objects are reproduced from National Geographic–Palomar Observatory Sky Survey. (B.G.D.)

34026 INTENSITY VARIATIONS OF QUASI-STELLAR SOURCES IN OPTICAL WAVELENGTHS. Sandage, Allan (Carnegie Inst. of Washington. California Inst. of Tech., Pasadena). Astrophys. J., 144: 1234-8(June 1966).

Photoelectric measurements of quasistellar sources (QSS's), which indicate variations in intensity are described. Data are presented which substantiates these variations. (B.G.D.)

34027 A SEARCH FOR A CLUSTER OF GALAXIES ASSOCIATED WITH 3C 48 USING THE KODAK SPECIAL PLATE TYPE 087-01. Sandage, Allan; Miller, William C. (Carnegie Inst. of Washington. California Inst. of Tech., Pasadena). Astrophys. J., 144: 1238-40(June 1966).

An experimental emulsion (Kodak Special Plate Type 087-01) was tested with a 200-in. telescope on 3C48 and results indicate a gain in limiting magnitude against the sky background. (B.G.D.)

34028 NEW SPECTROSCOPIC OBSERVATIONS OF FOURTEEN QUASI-STELLAR SOURCES. Lynds, C. R.; Hill, S. J.; Heere, Karen; Stockton, A. N. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 144: 1244-9(June 1966).

Data are presented on fourteen quasistellar sources including measured wavelengths of principal observed lines and adopted results, line identifications, and computed rest wavelengths. (B.G.D.)

34029 A MEASUREMENT OF THE ANGULAR SIZE OF THE X-RAY SOURCE SCO X-1. Gursky, H.; Giacconi, R.; Gorenstein, P.; Waters, J. R.; Oda, M.; Bradt, H.; Garmire, G.; Sreekantan, B. V. (American Science and Engineering, Inc., Cambridge, Mass. Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 144: 1249-52(June 1966).

An experiment is described in which the angular size of the x-ray source Sco X-1 was measured. The experiment was accomplished with a pair of independent modulation collimators as the payload of the Aerobee 150 rocket (1966). (B.G.D.)

34030 X-RAY EMISSION FROM SCO X-1. Manley, Oscar P. (American Science and Engineering, Inc., Cambridge, Mass.). Astrophys. J., 144: 1253-7(June 1966).

The new bound on the angular diameter of the x-ray source Sco X-1 established by Gursky and collaborators indicates the existence of a new class of celestial objects. The possibility that these objects are members of the galaxy is explored and it is suggested that they played a possible role in stellar evolution. (B.G.D.)

34031 INTERPLANETARY GAS. XII. A CATALOGUE OF COMET-TAIL ORIENTATIONS. Belton, Michael J. S.; Brandt, John C. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., Suppl. Ser., 8: 125-331(June 1966).

Some 1600 observations of the position angle of comet tails, including both original and published measurements, are reduced to orientations in the plane of the orbit of the comet. Measured and computed quantities are given together in the tabulation. Also given are the vectors which describe the geometrical circumstances at the time of observation. These observations are of value not only from the standpoint of the physics of comet tails but also in computing the velocity of the solar wind and/or for testing models of the interplanetary plasma. (auth)

34032 MASS POINT IN AN OSCILLATING WORLD MODEL. Pachner, J. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech., 17: 99-104(1966).

On the basis of Newtonian cosmology the influence of a massive central body upon the distribution of the density of a cosmic "dust" is investigated under the assumption that at the moment $t = 0$ the uniformly and isotropically distributed dust is expanding according to the Hubble law. An explicit expression for the density of matter is deduced and for a certain special case is graphically represented in the form of a diagram in which the radial distance from the central body is the independent variable and a dimensionless quantity, the time multiplied by H_0, i.e., the Hubble "constant" for $t = 0$, is a parameter. (auth)

34033 CLASSIFICATION OF THE EXACT SPHERICALLY SYMMETRIC SOLUTIONS OF EINSTEIN EQUATIONS WITH A VANISHING PRESSURE OF MATTER. Pachner, J. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech., 17: 105-8(1966).

The classification is carried out on the basis of the exact solution of Einstein field equations obtained by Datt (1938). It is shown that all these solutions may be divided into two large classes. The first corresponds to a wholly empty space which is either flat and static, or negatively curved and expanding. The other class is represented by spaces filled either wholly or partly by matter with a vanishing pressure. These spaces are always expanding or contracting, and may be either flat or curved negatively as well as positively. (auth)

34034 CONTRIBUTION TO THE PROBLEM OF A GRAVITATIONAL COLLAPSE OF MATTER. Pachner, J. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech., 17: 108-11(1966).

The gravitational collapse of a spherically symmetric body without an internal pressure and without radiation and rotation is investigated on the basis of general relativity. The problem is solved for three special cases, corresponding to the parabolic, hyperbolic and elliptic velocity of matter. In order to reach the continuity of the components of the metric tensor across the boundary of the collapsing matter, the assumption of a uniform and isotropic initial distribution of matter, used in the earlier papers, must be abandoned. The more the initial distribution differs from a uniform and isotropic one, the larger is the minimum radius to which the collapsing matter contracts. (auth)

34035 A SOLUTION OF THE MAGNETOHYDRODYNAMIC EQUATION AND ITS PROPOSED APPLICATION FOR THE THEORY OF SOLAR MAGNETIC FIELD. Csada, I. K. (Konkoly Observatory, Budapest). Bull. Astron. Inst. Czech., 17: 131-6(1966).

An exact solution for the magnetohydrodynamic equation is given in the case of infinite electrical conductivity. As a conclusion of the stability criteria for the periodical solution, force-free components are introduced for the magnetic field. The parameters are determined so that the field will be able to move with the material without loss. A simplified form, which contains the characteristics of a thermally controlled large-scale meridional circulation in a fluid globe, is introduced for the velocity field into the numerical calculation. As the problem has well defined boundary conditions, a procedure coupling the internal field through an atmospheric area to the external field is shown. (auth)

34036 THE H^- EMISSION IN FLARES. Svestka, Z. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 17: 137-40(1966).

Since all processes discussed hitherto have failed to explain the continuous emission of flares in the optical region, it is of interest to note that the formation of negative hydrogen ions in flares cannot be fully rejected as the possible cause of the flare continua. Using known physical data on three solar flares, it is shown that this process could produce the observed continuous emission in such flares or flare elements, in which the Lyman alpha radiation temperature is lower than ~7500°K. If such flares or flare elements existed, they would probably be situated very low in the chromosphere. In such a case, a heating of the upper photospheric layers beneath the flare or of some grains inside the photosphere might also participate in the formation of the flare continua. The wavelength variation of the relative intensity of the H^- continuous emission is in good agreement with observation for flares situated in limb parts of the solar disc. (auth)

34037 FLIGHT TIME OF SOLAR COSMIC AND PROTON RADIATION TO THE EARTH. SUPPLEMENT I. Krivsky, L. (Astronomical Inst. Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 17: 141-4(1966).

Ejections of solar cosmic rays or of protons that produce the PCA (polar cap absorption) effect are considered to originate in flares with a Y-shaped phase of development at the time of their rapid blaze up (Křivský 1963, 1965). Thus the exact time of the ejection and escape of the particles (coincident with the first top of radio emission on cm or dm) is known. The time lag of the beginning of the PCA effect or of the beginning of the increase of cosmic radiation after the occurrence of the Y-shaped phase in the respective flare is determined. With cosmic radiation the delay ranges between 3 and 85 minutes (+ 8^m for light), with particles producing the PCA-effect it ranges from 10 to 870 minutes (+ 8^m for light). Data are given on further flares with a phase of particle ejection, and on PCA effects. Corrections of supplementary data for the flares and flight times of corpuscles already published (Křivský 1965) are given. (auth)

34038 SOME NOTES ON THE FORM OF POLAR CORONAL RAYS. Kopecky, M.; Suda, J. (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Bull. Astron. Inst. Czech., 17: 144-9(1966).

The relation between the form of polar coronal rays and the over-all form of the solar corona, the dependence of the change in angle α between the coronal ray and the normal to the limb of the solar disc on the distance from this limb, and eventually, the forms of polar coronal rays resulting from this change are discussed. (auth)

34039 RADIUS OF SCHWARZSCHILD SINGULARITY IN COSMOLOGICAL BACKGROUND. Shah, K. B. (Physical Research Lab., Ahmedabad, India). Curr. Sci. (India), 35: 359(July 20, 1966).

An energy interpretation of the Schwarzschild surface singularity in general relativity theory is considered for the case where the spherical material system is embedded in a cosmological background. The radius in the Schwarzschild coordinates is found to be $\gamma_1 = 2.096$ m. It is concluded that the presence of the cosmological background increases the radius of the event horizon by about 4.8%. (L.B.S.)

34040 TRITIUM CONTENT OF TWO CHONDRITES. Begemann, F. (Max-Planck-Institut fuer Chemie, Mainz). Earth Planet. Sci. Lett., 1: 148-50(July 1966).

The tritium content of the chondrites Kiel and Pantar was measured to be (450 ± 30) and (580 ± 60) dpm/kg, respectively. As Kiel has an exceptionally high ratio $^3He/^{21}Ne = 10.3$, its normal tritium activity represents further evidence that the variable $^3He/^{21}Ne$ ratios found in chondrites are not caused predominantly by a variation of the ^3He production rate. (auth)

34041 THE THERMAL HISTORY OF THE BRUDERHEIM METEORITE. Turner, G. (Univ. of Sheffield, Eng.); Miller, J. A.; Grasty, R. L. Earth Planet. Sci. Lett., 1: 155-7(July 1966).

An activation technique was used to show that the spatial distributions of K and radiogenic ^{40}Ar in the meteorite Bruderheim are different. It is deduced that Bruderheim was heated 495 ± 30 m.y. ago at which time it lost around 90% of its radiogenic ^{40}Ar. (auth)

34042 SEARCH FOR SOLAR AND COSMIC GAMMA RAYS. Frye, G. M. Jr. (Case Inst. of Tech., Cleveland); Reines, F.; Armstrong, A. H. J. Geophys. Res., 71: 3119-23(July 1, 1966).

A balloon flight was made on March 16, 1959, near the peak of the last solar cycle, to search for solar γ rays. Although two active regions were visible on the sun, the γ radiation above 20 Mev was $<2.8 \times 10^{-2}$ photons cm^{-2} sec^{-1}. Upper limits $\leq 10^{-2}$ photons cm^{-2} sec^{-1} were also set for M 31, M 82, Cygnus A, Cassiopeia A, and B Cassiopeiae. The integral γ-ray energy spectrum is $N(>E) \propto E^{-0.50 \pm 0.06}$ for $20 < E_\gamma < 100$ Mev, and $N(>E) \propto E^{-0.87 \pm 0.14}$ for $100 < E_\gamma < 500$ Mev. (auth)

34043 ORIGIN OF METEORITES: SPACE EROSION AND COSMIC RADIATION AGES. Fisher, David E. (Cornell Univ., Ithaca, N. Y.). J. Geophys. Res., 71: 3951-9 (July 1, 1966). (NYO-2794-1).

It is suggested that the erosion of chondritic meteorites

by interplanetary dust is a mechanism that can account satisfactorily for the cutoff in radiation ages at 55×10^6 years, if the meteorites have an asteroidal origin. Spectra of chondritic radiation ages are calculated, based on a model involving continuous meteorite creation in the asteroidal belt and coupled with several erosion rates, and are compared to experimental results. The calculated and experimental spectra are in good agreement. (auth)

34044 HIGH-ENERGY X RAYS FROM THE CRAB NEBULA. Haymes, R. C.; Craddock, W. L. Jr. (Rice Univ., Houston, Tex.). J. Geophys. Res., 71: 3261-4 (July 1, 1966).

A balloon measurement of the x radiation from the Crab nebula was conducted. The energy range from 23 to 455 kev was examined with increased sensitivity, and a spectrum over a broader range than previously possible was deduced. The x-ray spectrum at photon energies up to 90 kev is discussed. (J.F.P.)

34045 ANISOTROPY AND FLUCTUATIONS OF SOLAR PROTON FLUXES OF ENERGIES 0.6-100 Mev MEASURED ON THE PIONEER 6 SPACE PROBE. Fan, C. Y.; Lamport, J. E.; Simpson, J. A.; Smith, D. R. (Univ. of Chicago). Contracts NASA NAS 2-1758; AF 19(628)-2473. J. Geophys. Res., 71: 3289-96(July 1, 1966).

Preliminary results are presented from the investigation of the direction of arrival of particles near the plane of the ecliptic and the time resolution required for observing rapid fluctuations of particle intensity in space. Topics discussed include the instruments and the probe trajectory, proton differential energy spectra, the proton flux anisotropy, proton rapid-intensity oscillations, modulation of galactic cosmic rays, and proton intensity regions co-rotating with the sun. (J.F.P.)

34046 PRELIMINARY RESULTS FROM THE PIONEER 6 MAGNETIC FIELD EXPERIMENT. Ness, N. F.; Scearce, C. S.; Cantarano, S. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 71: 3305-13 (July 1, 1966).

Preliminary results are presented from measurements of the interplanetary magnetic field by Pioneer 6. It is concluded from these data that the interplanetary field is composed of a large number of separate filamentary tubes that originate at the sun. These are intertwined with each other but ordered to produce a longitudinal sectoring of field direction as measured at 1 AU associated with the solar wind convected photospheric fields. (J.F.P.)

34047 SIMULTANEOUS MEASUREMENTS OF THE INTERPLANETARY MAGNETIC FIELD. Ness, N. F. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 71: 3319-24(July 1, 1966).

Preliminary results of a comparison of interplanetary magnetic measurements from the Pioneer 6 space probe and the IMP 3 satellite are reported. The investigation of interplanetary magnetic field structure, that is identifiable as co-rotating with the interplanetary medium as the solar wind convects lines of force attached to the sun into interplanetary space, is emphasized. The general model of the solar origin of the regular interplanetary magnetic field initially suggested by Parker is supported. (J.F.P.)

34048 INTERPLANETARY ELECTRON NUMBER DENSITY FROM PRELIMINARY ANALYSIS OF THE PIONEER 6 RADIO PROPAGATION EXPERIMENT. Eshleman, V. R.; Garriott, O. K.; Leadabrand, R. L.; Peterson, A. M. (Center for Radar Astronomy, Palo Alto, Calif.). Contract NAS2-1759. J. Geophys. Res., 71: 3325-7(July 1, 1966).

A preliminary report is given on one aspect of the radio propagation experiment on Pioneer 6. From an analysis of a small fraction of the differential group-path data from Pioneer and simultaneous ionospheric measurements using signals from two Beacon satellites it was determined that the average interplanetary electron number density near the earth's orbit was between 8 and 9 cm^{-3} in the time interval from February 20 to April 9, 1966. (J.F.P.)

34049 COMPOSITIONAL, ANISOTROPIC, AND NON-RADIAL FLOW CHARACTERISTICS OF THE SOLAR WIND. Wolfe, J. H.; Silva, R. W.; McKibbin, D. D.; Mason, R. H. (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res., 71: 3329-35(July 1, 1966).

Data on plasma characteristics in the interplanetary medium observed by a plasma probe on Pioneer 6 are presented. The results show deviations from radial plasma flow of as much as 5° and reveal a high degree of thermal anisotropy in the plasma ions. These data indicate that the ion temperature parallel to the magnetic field may at times exceed the perpendicular temperature by an order of magnitude. There was also evidence for the presence of a third ionic species in the solar wind. (J.F.P.)

34050 MASS EJECTION BY HIGHLY EVOLVED STARS. Greyber, Howard D. (Imperial Coll. of Science and Tech., London). Nature, 210: 510-11(Apr. 30, 1966).

A new mechanism is proposed for rapid mass ejection from highly evolved stars. The mechanism is effective only over a specific, relatively short period of time in the life of the star. (B.G.D.)

34051 A POSSIBLE IDENTIFICATION OF THE X-RAY SOURCE Sco X-3. Tammann, G. A. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Nature, 210: 511(Apr. 30, 1966).

The positional coincidence of the x-ray source Sco X-3 with an extended H II emission region which may be the remnant of a supernova explosion is examined. (B.G.D.)

34052 POTASSIUM–ARGON AGE FOR THE BARWELL METEORITE. Gale, N. H. (Oxford Univ.); Grasty, R. L.; Meadows, A. J. Nature, 210: 620(May 7, 1966).

A potassium-argon age was determined for the olivine-hypersthene chondrite that fell at Barwell, Leicestershire, on December 24, 1965. (B.G.D.)

34053 INTERPRETATION OF THE LINE SPECTRA OF QUASI-STELLAR OBJECTS. Burbidge, G. R. (Univ. of California, San Diego, La Jolla); Burbidge, Margaret; Hoyle, F.; Lynds, C. R. Nature, 210: 774-8(May 21, 1966).

An attempt is made to account for the widths of the line spectra and the different stages of ionization of quasi-stellar objects observed in the past few years. (B.G.D.)

34054 RELATION BETWEEN THE RED SHIFTS OF QUASI-STELLAR OBJECTS AND THEIR RADIO AND OPTICAL MAGNITUDES. Hoyle, F. (Cambridge Univ., Eng.); Burbidge, G. R. Nature, 210: 1346-7(June 25, 1966).

A small sample of quasi-stellar objects (30) showed the usual relation between Log N and Log S, $NS^{\frac{3}{2}}$ being approximately constant. The result $NS^{\frac{3}{2}}$ approximately constant has always been interpreted in terms of distances and volumes. A similar interpretation for sample of quasi-stellar objects requires the objects with smaller S to be at the greater distance, in any event statistically. Objects with $S \approx S_4$, should be statistically farther away than objects with $S \approx S_3$, and so on. If it is assumed that the red-shifts Z of the quasi-stellar spectra arise from the cosmological expansion of the universe, then small S must be correlated with large Z. However, it is shown that this is not so. Thus, if the usual distance-volume interpretation of the result $NS^{\frac{3}{2}} \approx$ constant, is adopted, it must be concluded that the red-shifts have nothing to do with distances. Illustrations are given for red-shift versus optical and radio magnitudes for quasi-stellar objects. (P.C.H.)

34055 NUCLEI OF QUASARS AS AN OSCILLATORY GRAVITATIONAL COLLAPSE. Herzenstein, M. E.; Aivazyan, Yu. M. (All-Union Scientific Inst. of Physical-Technical and Radio-Technical Measurements, Moscow). Phys. Lett., 22: 62-3(July 15, 1966).

The oscillatory gravitational collapse can be seen outside; the emission of energy is not forbidden. The hypothesis of gravitational collapse in the quasar nuclei explains the big energy release, the brightness modulation and big time of existence. (auth)

34056 GRAVITATIONAL COLLAPSE: PERIODIC MOVEMENT. Herzenstein, M. E. (All-Union Scientific Inst. of Physical-Technical and Radio-Technical Measurements, Moscow). Phys. Lett., 22: 69-70(July 15, 1966).

In the nonrelativistic case of the powdered matter the gravitational collapse is oscillatory. The oscillatory nature of the collapse is preserved in the general theory of relativity and can be obtained directly from the causality principle. (auth)

34057 NATURE OF SINGULARITIES IN RELATIVISTIC WORLD MODELS. Pachner, Jaroslav (Astronomical Inst., Prague). Phys. Rev., 147: 910-12(July 29, 1966).

It is shown that the puzzle of a discontinuous inversion of velocities of particles at the moment of maximum contraction of Friedman universes is removed by the assumption that the square root of the reciprocal absolute value of the Riemannian curvature of the three-dimensional space takes on not only positive, but also negative values. Further it is proved that the replacement of the usual uniform and isotropic distribution of the cosmic dust by a spherically symmetric distribution prevents contraction of the world model to a zero volume, but it does not prevent the occurrence of singularities in the density of matter at the center of symmetry. However, it may be expected that the abandonment of all symmetry in the distribution of matter, as observed in the actual universe, in connection with the fact that no sudden inversion of velocities takes place, will also avoid the occurrence of these singularities. (auth)

34058 ANISOTROPIC PROPAGATION OF SOLAR PROTONS DEDUCED FROM SIMULTANEOUS OBSERVATIONS BY EARTH SATELLITES AND THE MARINER-IV SPACE PROBE. O'Gallagher, J. J.; Simpson, J. A. (Univ. of Chicago). Phys. Rev. Lett., 16: 1212-17(June 27, 1966).

Experimental evidence that some solar-flare protons are strongly confined to propagate in magnetic field regions that have the same characteristics as corotating sector structures and that the proton fluxes share this corotation is presented. It is also shown that the anisotropic propagation is so dominated by the prevailing magnetic field structure that differences in heliocentric longitude less than 40° are decisive for whether or not solar-flare particles may reach the earth or any given point in space. Some evidence that the protons continually observed as 27-day recurring events in earlier experiments are confined to corotating regions extending beyond 1.5 au for several solar rotations is also presented. The data presented were obtained during special interplanetary conditions associated with the minimum in the solar activity cycle. (G.O.Y.)

34059 TEMPORAL INDEPENDENCE OF THE OCCURRENCE OF SMALL SCALE IRREGULARITIES IN THE INTERPLANETARY MAGNETIC FIELD. McCracken, K. G.; Rao, U. R. (Southwest Center for Advanced Studies, Dallas). Planet. Space Sci., 14: 649-51(July 1966).

It can be shown that if there are no small-scale irregularities in the interplanetary field a cosmic-ray density gradient will be established which exactly cancels the anisotropy due to the co-rotation effect. If small-scale irregularities are present the density gradient is reduced to a value which is a function of the size and frequency of occurrence of small-scale field irregularities. Since experimental data show agreement with the co-rotation theory, it is proposed that the observed temporal changes in the diurnal cosmic ray anisotropy can be used to study the time changes of the cosmic ray density gradient and hence of the small-scale interplanetary magnetic field irregularities in the vicinity of the earth's orbit. (J.F.P.)

34060 THE SUN: THE XUV SPECTRUM. McNally, D. (London Univ.). Sci. Progr. (London), 54: 275-82 (Summer 1966).

The major features of the solar XUV spectrum were reviewed. Some of the results derived from a study of the spectrum are discussed. (auth)

34061 PYGMY STARS: FIRST PAIR. Zwicky, F. (California Inst. of Tech., Pasadena. Carnegie Inst. of Washington). Science, 153: 53-4(July 1, 1966).

The binary LP 101-15/16 having the proper motion of 1.62 seconds of arc per year was studied with the prime-focus spectrograph of the 200-inch (508-cm) telescope. Indications are that LP 101-15/16 is the first pair of pygmy stars ever discovered. One of its components, LP 101-16, is probably a blue pygmy star which is at least four magnitudes fainter than the ordinary white dwarfs. Also, two of the Balmer lines in absorption appear to be displaced toward the red by amounts which indicate the existence of an Einstein gravitational red shift corresponding to about 1000 km sec^{-1}. On the other hand LP 101-15 is red and shows an entirely new type of spectrum, which suggests that it may be a first representative of a type of red pygmy star which is 2.5 magnitudes fainter than the M-type dwarf stars of the main sequence. (auth)

34062 COSMIC RAYS AND PLASMA PHENOMENA IN THE GALAXY AND METAGALAXY. Ginzburg, V. L. (Lebedev Inst. of Physics, Moscow). Soviet Astron. AJ (Engl. Transl.), 9: 877-81(May-June 1966).

Translated from Astron. Zh., 42: 1129-34(Nov.-Dec. 1965).

It is suggested that various instabilities taking place in the interstellar and intergalactic plasma substantially influence the direction and energy distribution functions, as well as the spatial distribution and diffusion of cosmic rays. As a result, calculations of plasma phenomena acquire fundamental significance in the astrophysics of cosmic rays and in theories of their origin. In particular, the presence of the instabilities must lead to the rapid and practically complete randomizing of cosmic-ray velocities both in galaxies and in metagalactic space. In transition regions between strong and weak fields, cosmic rays emerging from the strong-field region will develop turbulence, thereby resulting in "self-closure." (auth)

34063 SPECTRA AND NATURE OF THE RADIO EMISSION OF NORMAL GALAXIES. Kuril'chik, V. N. (Shternberg Astronomical Inst., USSR). Soviet Astron. AJ (Engl. Transl.), 9: 884-92(May-June 1966).

Translated from Astron. Zh., 42: 1138-49(Nov.-Dec. 1965).

The results of radio observations of normal galaxies are discussed from a unified viewpoint. Revised radio spectra are given for 20 galaxies. Galaxies often contain fairly intense radio sources near their nuclei. Transformation by synchrotron losses of the energy spectrum of relativistic electrons escaping from the central regions produces the radio spectra of extended sources. Central sources have a spectral index of 0.6 ± 0.1, while for extended sources the index changes by 0.5 at high frequencies, becoming 1.1 ± 0.1. Estimates for the cosmic-ray and magnetic-field energy in central and extended sources show that injection of relativistic particles from circumnuclear regions is fully capable of furnishing the observed radio intensity of the extended sources if the injection is quasicontinuous. A disk model best represents extended sources. The thermal radio emission observed in several galaxies is discussed. (auth)

34064 REABSORPTION OF SYNCHROTRON RADIATION IN DISCRETE SOURCES. Braude, S. Ya. (Inst. of Radiophysics and Electronics, Academy of Sciences, Ukrainian SSR). Soviet Astron. AJ (Engl. Transl.), 9: 893-5(May-June 1966).

Translated from Astron. Zh., 42: 1150-3(Nov.-Dec. 1965).

It is shown that the nonuniform distribution of synchrotron radiation must be considered in discrete radio sources where reabsorption is observed, and that previously applied criteria for the presence of synchrotron self-absorption are not satisfactory. (G.O.Y.)

34065 THERMODYNAMIC PROPERTIES OF MATTER AT HIGH DENSITIES AND TEMPERATURES. Imshennik, V. S.; Nadezhin, D. K. Soviet Astron. AJ (Engl. Transl.), 9: 896-906(May-June 1966).

Translated from Astron. Zh., 42: 1154-67(Nov.-Dec. 1965).

The thermodynamics of matter for temperatures in the

range 10^9 to 20×10^9°K and densities in the range 10^5 to 10^{10} g/cm³ is discussed. Such physical conditions are found in the interiors of massive stars (with masses of several tens of solar masses) immediately before and in the process of collapse. According to the hypothesis of Hoyle and Fowler this collapse is due to the decay of iron to helium, protons and neutrons and is evidenced as a type II supernova outburst. The relativistic degeneration of electrons and positrons, pair and photon production, beta processes, and nuclear reactions in the mixture ^{56}Fe, ^{4}He, p, and n is taken into account in the calculations. All the results are obtained assuming total statistical equilibrium. In the form of equations of state, they can be used for investigating the dynamics of collapse. The equilibrium process of neutronization of matter for the above temperature range and for densities up to 3×10^{12} g/cm³ is also studied. (auth)

34066 NUCLEAR REGIONS OF GALAXIES. I. PHOTOMETRIC PROPERTIES. Vorontsov-Vel'yaminov, B. A. (Shternberg Astronomical Inst., USSR). Soviet Astron. AJ (Engl. Transl.), 9: 907-18(May-June 1966). Translated from Astron. Zh., 42: 1168-83(Nov.-Dec. 1965).

A provisional description is attempted of the gross properties of nuclear regions of galaxies with emphasis on their diversity; clarification of terminology is proposed. The uncertain information on the central cores of galaxies is reviewed and unified. Magnitudes are derived for nuclear regions from special size measurements based on published photoelectric data acquired with small diaphragms. With Gorbachev's additional photographic measurements of nuclei, which are a part of the author's program, a catalog of the nuclear regions of 173 galaxies, was compiled giving the absolute magnitude, surface brightness, luminosity l per pc³, and magnitude difference between the nuclear region and the entire galaxy. Statistical analysis shows that nuclear luminosity increases with total luminosity for all galaxy types, while l is larger for less red nuclei and later-type galaxies. Nuclear regions of giant galaxies are comparable to large elliptical galaxies in luminosity. (auth)

34067 COMPUTATIONS OF EARLY EVOLUTIONARY STAGES IN STARS OF 15.6, 20, AND 30 SOLAR MASSES. Kotok, E. V. (Astronomical Council, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 9: 948-52(May-June 1966). Translated from Astron. Zh., 42: 1221-7(Nov.-Dec. 1965).

The early evolutionary stages of model stars with masses of 15.6, 20, and 30$M_\odot$ were studied. The mass dependence of certain stellar parameters was derived. (D.C.W.)

34068 NEUTRINO GENERATION IN THE SOLAR INTERIOR. Kuz'min, V. A. (Lebedev Inst. of Physics, Moscow). Soviet Astron. AJ (Engl. Transl.), 9: 953-6 (May-June 1966). Translated from Astron. Zh., 42: 1228-31(Nov.-Dec. 1965).

Neutrino generation in the ^{3}He(p,e$^+\nu$)^{4}He reaction in the solar interior is considered. It is compared to other neutrino-producing reactions in terms of the solar mass distribution of neutrino sources. The effective solar masses participating in the generation of ^{8}B neutrinos and (^{3}Hep) neutrinos are found to be 0.03 $M_\odot$ and 0.57 $M_\odot$ respectively. The (^{3}Hep) neutrino intensity distribution peaks at $M_r \approx 0.05\ M_\odot$ ($r \approx 0.08\ R_\odot$). (auth)

34069 ESTIMATES FOR THE MAGNETIC FIELD STRENGTH IN THE SOLAR CORONA FROM TYPE II RADIO BURSTS. Fomichev, V. V.; Chertok, I. M. (Inst. of Terrestrial Magnetism, the Ionosphere, and Radio Propagation, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 9: 976-9(May-June 1966). Translated from Astron. Zh., 42: 1256-60(Nov.-Dec. 1965).

The Pikel'ner-Ginzburg generation mechanism for type-II bursts yields an estimate for the coronal magnetic field above an active region. The basic burst parameters — maximum (initial) frequency of the first harmonic, the corresponding height in the corona, velocity of the exciting agent — are derived from the dynamic spectrum and Newkirk's model for the height distribution of the electron concentration. Field strengths are computed for 20 bursts. The field above an active region is 5 to 8 gauss at a height of ~150,000 km, declining to 1.2 to 2.0 gauss at ~400,000 km. (auth)

34070 OPTICAL OBSERVATIONS OF SOLAR FLARES. Svestka, Zdenek (Astronomical Inst., Czechoslovak Academy of Sciences, Ondrejov). Space Sci. Rev., 5: 388-418(May 1966).

A review of the results of optical observation of solar flares is presented. Observations carried out in the H_α line, flare spectra, and the methods of analyzing the flare spectra are briefly discussed. Great attention is paid to the continuous emission of flares in the optical spectral region. Optical aspects of proton flares are summarized. (auth)

34071 DETECTABILITY OF MOLECULAR HYDROGEN IN INTERSTELLAR SPACE. Varsavsky, Carlos M. (Univ. of Buenos Aires. Instituto Argentino de Radioastronomia, Buenos Aires). Space Sci. Rev., 5: 419-34 (May 1966).

A review is presented concerning the structure and spectrum of the hydrogen molecule; the processes that in interstellar space can lead to the formation and to the dissociation of the hydrogen molecule with the aim of establishing its abundance, both on the average and in particular regions of the Galaxy, and the lines originating from interstellar molecular hydrogen that could be observed from the Earth. In this last section the possible observations are classified from the point of view of the height in the atmosphere from which they have to be made. (auth)

34072 FIZIKA ZVEZD I MEZHZVEZDNOI SREDY. (Stellar and Interstellar Space Physics). Bogorodskii, A. F. (ed.). Kiev, Izdatel'stvo Nauka Dumka, 1966. 195p.

Fifteen papers are included. A separate abstract was prepared for one. The other papers are on the internal structure of stars, stellar atmospheres, the spectral classification of stars, methods for spectrophotometric and and photometric studies, telescopic corrections, variable stars, long- and ultrashort-period cepheids, polarization of continuous stellar radiation, and analog-digital coding converters. (M.J.T.)

For an abstract of the individual paper see: 34770.

34073 X-RADIATION OF THE SUN. Acton, Loren Wilber. Boulder, Colo., Univ. of Colorado, 1965. 284p. Thesis.

On 29 June 1961 two artificial earth satellites that carried detectors sensitive to soft x radiation were placed in orbit. These satellites, Solar Radiation 3 and Injun 1, provided a series of random observations of the solar x-ray flux in the $\lambda < 14$ Å band over the following months. A description of the experimental apparatus and the reduction and evaluation of these data are presented. A general discussion of the problem of interpreting observations made with nondispersive x-ray photometers is included. Understanding the physics of the x-ray emission of the sun involves identifying the dominant emission processes and defining the physical conditions in the solar atmosphere under which these processes operate. It is concluded that bremsstrahlung, normal recombination, and line emission are the predominant physical processes in all cases. Under special, nonthermal, conditions characteristic fluorescence radiation due to inner shell transitions of heavy atoms subject to electron bombardment may make a significant contribution to the x-ray flux at short ($\lambda \lesssim 5$ Å) wavelengths. The x-ray emission of the non-flaring sun seems to be simple thermal emission from coronal enhancements having electron densities of the order of 5×10^9 cm^{-3} and electron temperatures around 2 to 2.5 million degrees Kelvin. Flare x-ray emission manifests a great multiformity. The parameters leading to this multiformity of the solar flare x-ray event are specified. Both thermal and nonthermal processes appear to be important in flares. On the basis of the relative predominance of these two characteristics, and the maximum electron energies involved in the non-

thermal component, four categories of solar x-ray flares are defined. Examples of each of these types are given and rudimentary models are derived for each class. (Dissertation Abstr.)

34074 MATHEMATICAL FRAMEWORK FOR DISCUSSING THE STATISTICAL DISTRIBUTION OF GALAXIES IN SPACE AND ITS COSMOLOGICAL IMPLICATIONS. Gunn, James Edward. Pasadena, Calif., California Inst. of Tech., 1966. 230p.

Thesis.

The spectral-theoretic techniques of stationary time-series analysis are generalized and applied to the study of the statistical distribution of galaxies in space and the observed distribution in the sky. Sampling techniques and criteria are developed for the measurement of the Fourier transform of the autocovariance function, the so-called power spectrum. The theory is extended to curved, nonstatic space-times and the possibility of using the spectral density obtained from counts of galaxies in the formulation of cosmological tests is discussed. A similar development is made for the statistical structure of the background light due to very faint galaxies, and the possibility of measurement of this structure and its application to cosmological tests is considered. It is shown that in both cases (counts and background) significant cosmological data can be obtained if knowledge of the luminosity function, the spectra, and the evolution of galaxies is improved. Finally, application is made of the theory to the analysis of a small-count problem in order to learn something about the general form of the spatial covariance. (Dissertation Abstr.)

34075 1. RATES OF NUCLEAR REACTIONS IN WHITE-DWARF STARS. 2. THE COOLING OF NEUTRON STARS. Wolf, Richard Alan. Pasadena, Calif., California Inst. of Tech., 1966. 132p.

Thesis.

The motion of the nuclei in the interior of a white dwarf is similar to the motion of the atoms in a solid or liquid. A method is proposed for calculating the rate at which a nuclear reaction proceeds between two identical nuclei oscillating about adjacent lattice sites. An effective potential $U(\underline{r})$ derived by analyzing small lattice vibrations is used to represent the influence of the Coulomb fields of the lattice on the motion of the two reacting nuclei. The wave function describing the relative motion of the two reacting particles is obtained by solving a Schrödinger equation containing the effective potential $U(\underline{r})$. From this wave function an expression for the reaction rate is derived. Applied to the p + p reaction, this method predicts a reaction rate about 100 times the original estimate made by Wildhack; applied to the $^{12}C + {}^{12}C$ reactions, the method implies a rate about ten orders of magnitude smaller than the rate calculated by the method previously suggested by Cameron. The emission of neutrinos from neutron stars is studied, and those characteristics of neutron-star matter that affect cooling are investigated. The validity of the particle model is discussed. The effects of strong interactions on the composition of neutron-star matter are described. The question of superfluidity in the neutron-proton gas is discussed, and the limit of stability of the nucleon-gas to formation of "nuclei" is estimated. Calculations of the rates of the cooling reactions $n + n \rightarrow n + p + e^- + \bar{\nu}_e$ and $n + \pi^- \rightarrow n + e^- + \bar{\nu}_e$ are presented; the rates of the closely related muon-producing reactions and the four inverse processes are also given. The calculated cooling rates indicate that a neutron star containing quasi-free pions would cool within a few days to a temperature so low that photon emission from the star's surface would be unobservable. It is possible to establish a lower limit on the cooling rate of a neutron star. This lower limit implies that the discrete x-ray sources located in the direction of the galactic center are probably not neutron stars. (Dissertation Abstr.)

34076 HYPERTHERMAL PROCESSES IN THE SOLAR ATMOSPHERE. Wood, Lowell Lincoln Jr. Los Angeles, Univ. of California, 1965. 163p.

Thesis.

Work dealing both theoretically and experimentally with hyperthermal regions and processes in the solar atmosphere is presented, with particular emphasis on processes that may involve nuclear reactions to a substantial extent. Data from the hydrogen Lyman alpha detector and the extreme ultraviolet (EUV) and gamma ray spectrometers on the first Orbiting Solar Observatory (OSO-1) are presented and correlated with simultaneous ground-based observations. These data are interpreted as indicating that the atmosphere of the normally quiet sun is far from quiet, that portions of it are fairly continuously characterized by violence in both the velocity and radiative fields of a magnitude observed visually only in centers of activity during flare-like events, and that nuclear processes apparently accompany this violent activity. Previously obtained observational results are discussed in conjunction with relevant theoretical studies. It is concluded that the OSO-1 data may be qualitatively interpreted by an extension of the Alfvén-Osterbrock model for the heating of the solar atmosphere by magnetohydrodynamic shock waves associated with the network of regions of enhanced magnetic field on the solar surface. The astrophysical implications of the model introduced to interpret solar data are discussed, along with some of the relevant observational data. It is concluded that the sun is a relatively poor example of the processes probably involved in the present model, and that somewhat more vigorously convecting stars may display hyperthermal processes to far greater extents. Some of the geophysical implications of the data and of this model are then discussed, including the heating of the upper atmosphere by the solar EUV and the interaction of the solar wind with the magnetosphere. A series of observational programs to test the present model and answer some of the questions it raises is briefly outlined. (TCO)

34077 PRIMEVAL HELIUM ABUNDANCE AND THE PRIMEVAL FIREBALL. Peebles, P. J. E. (Palmer Physical Lab., Princeton, N. J.). 11p. (CONF-660107-35). ORAU. Gmelin, AED-CONF-66-003-61.

From American Physical Society Meeting, New York.

The results of a recent calculation of the primeval element abundances issuing from big bang cosmology is presented. These depend on two observable quantities, the temperature of the fireball radiation and the mean mass density in the universe. (B.G.D.)

Atomic Physics

Refer also to abstracts 33256 and 34630.

34078 (N-65-32048) QUANTUM CORRECTIONS TO THE TRANSPORT COLLISION INTEGRALS. Wood, Herbert T. (Wisconsin Univ., Madison. Theoretical Chemistry Inst.). Aug. 10, 1965. 99p. (NASA-CR-64558; WIS-TCI-111). CFSTI $3.00 cy, $0.75 mn.

The second quantum correction to the phase shift in a collision between particles with spherically symmetric potentials is obtained, using the method of Curtiss and Powers. In this expression the potential is not restricted to monotonic functions; the results apply to a potential with an attractive minimum. The classical limit and the first quantum correction, both developed earlier for monotonic potentials, are also rederived so that they may be used with potentials possessing a minimum. These expressions are then used to develop series expressions for $Q^{(1)}$ and $Q^{(2)}$, the so-called cross sections for diffusion and viscosity, respectively. These expressions for $Q^{(1)}$ and $Q^{(2)}$ are used to obtain the classical limit and the quantum corrections to the transport collision integrals. (auth)

34079 (N-65-32195) QUANTUM CORRECTIONS TO THE TRANSPORT COLLISION INTEGRALS. PART 2. Wood, Herbert T. (Wisconsin Univ., Madison. Theoretical Chemistry Inst.). Aug. 10, 1965. 79p. (NASA-CR-64463; WIS-TCI-111(Pt.2)). CFSTI $3.80 cy, $0.75 mn.

The first and second quantum corrections to the cross sections $Q^{(1)}$ and $Q^{(2)}$ for collisions involving spherically

symmetric potentials were obtained. These expressions are not restricted to monotonic potentials. The expressions differ from those of Kahn, because of the use of a different boundary condition. The important feature of this work was the introduction of the concept of the classical limit and the distinction between this and the classical result. The coreless square well potential was studied to demonstrate this difference because the integrals involved are known. The numerical results for the phase shift, using the Lennard-Jones potential, substantiates the expression for this classical limit. Three sets of computer programs were used in the numerical evaluation of the expressions obtained, one set for each potential. (STAR)

34080 (N-66-16939) SEMICLASSICAL APPROACH TO CAPTURE COLLISIONS BETWEEN IONS AND POLAR MOLECULES. Dugan, John V. Jr.; Magee, John L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1966. 48p. (NASA-TN-D-3229). CFSTI $2.00 cy, $0.50 mn.

Quantum mechanical average cross sections are derived for low velocity capture collisions between ions and polar molecules. These cross section expressions incorporate the rotational energy of the molecule and are derived from the Stark interaction potential. A classical upper limit which is good for all ion velocities is presented for the capture cross section. Also, an approximate cross section is derived from classical considerations for the regime of high ion velocity by simple averaging over the static orientations of the polar molecule. Finally, a numerical calculation of the capture cross section is performed by randomizing initial conditions for two hypothetical molecules with fixed rotational energy at high values of ion velocity. The Lagrangian equations of motion are solved to obtain the capture cross section from a collision ratio. These cross sections are decreasing functions of molecular rotational energy and ion-molecule relative energy. The cross sections are discussed in the context of experimental results and the quantum theoretical predictions. This study of collision between hypothetical molecular species is intended to serve as a preliminary description of such events. (auth)

34081 (UCRL-16707) ON THE HYPERFINE STRUCTURE OF THE MOLECULES H_2^+, HD^+, AND D_2^+. Williams, Neville Allen Jr. (Lawrence Radiation Lab., Univ. of California, Berkeley). May 1966. Contract W-7405-eng-48. 100p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Thesis.

The hyperfine structure of each of the ions H_2^+, D_2^+, and HD^+ is examined and the hyperfine structure of D_2^+ in the zeroth rotational state is numerically calculated for the first nine vibrational states within the Born-Oppenheimer approximation. The first nine vibrational wave functions are numerically determined and used in the hyperfine structure calculation. An ion beam method for observing the radio-frequency spectrum of D_2^+ in the zeroth rotational state is discussed and the design and operation of a spectrometer, which was constructed and tested, is described in detail. (auth)

34082 (NP-tr-1376) DETERMINATION OF THE MASS OF IONIZED CLUSTERS IN CONDENSED CO_2 MOLECULAR BEAMS BY MEANS OF A RETARDING FIELD METHOD. Bauchert, J.; Hagena, O. F. (Technische Hochschule, Karlsruhe (West Germany)). Translated for Culham Lab., U.K.A.E.A., Abingdon, Eng., from report KVT-9/18. 22p. (CTO-224). Dep. mn. JCL $2.60 fs, $0.86 mf.

While investigating intense supersonic molecular beams during 1956 Becker, Bier, and Henkes found that under suitable initial conditions so-called "condensed" molecular beams can be obtained which consist of fairly large agglomerations or clusters of atoms or molecules held together by van der Waals' forces. Such condensation is possible if a supersaturated state is reached during the expansion of the gas forming the beam. Henkes showed that these clusters, occurring in supersonic molecular beams, can be ionized by electron bombardment and then accelerated electrically. The specific charge M/Z of the electrically accelerated ions in the cluster was measured. The measuring technique described here makes use of the high energy of the ions for the mass determination by measuring the potential required to retard the ions in the clusters in an electrical retarding field system. This is then used to determine the ratio of the number of molecules N to the charge Z of the ions. As an example of an application of the new technique the effect of the diameter a of the nozzle used to produce the beam, and the effect of the inlet pressure p_0 on the N/Z distribution was investigated. (M.O.W.)

34083 STUDY OF DISLOCATION DIPOLES PRODUCED BY IONIC BOMBARDMENT OF THIN GOLD FILMS. Fontaine, G.; Jouffrey, B. (Faculte des Sciences, Orsay, France). Acta Met., 14: 949-53(Aug. 1966). (In French).

Dislocation dipoles were produced during ionic bombardment (argon ions with an energy of 4000 ev) of gold crystals, obtained by evaporation, having a (001) orientation. The interaction of two dipoles at the same depth in the specimen on parallel planes near the (110) planes was studied. Evidence shows that during annealing the dipoles can condense to form only one dipole. A theory is proposed that explains this phenomenon as well as its kinetics. A second mode of condensation in addition to that observed is predicted. (auth)

34084 BORN CROSS-SECTIONS FOR DOUBLE-TRANSITION COLLISIONS OF HYDROGEN ATOMS. Pomilla, Frank R.; Milford, S. N. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Contract NASw-894. Astrophys. J., 144: 1174-93(June 1966).

The collisions of two hydrogen atoms in which both atoms jump to higher quantum levels are studied. Born total cross sections are calculated for center-of-mass energies in the range 2 kev to 100 Mev for reactions in which one of the atoms is initially in the ground state and the other is in either the ground or an excited state, and also for reactions in which both atoms are initially in excited states. Total level cross-sections for $(n \rightarrow n')$ transitions are calculated from the cross sections for the transitions $(nl \rightarrow n'l')$ between different electronic orbitals by taking the appropriate averages over l and summations over l'. Our results are in good agreement with previous related theoretical and experimental work. (auth)

34085 STIMULATED EMISSION OF RADIO-FREQUENCY LINES OF HYDROGEN. Goldberg, Leo (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 144: 1225-9(June 1966).

The determination of electron temperatures of H II regions from observed intensities of r-f lines emitted in transitions between adjacent highly excited levels of hydrogen is discussed. (B.G.D.)

34086 PRODUCTION OF SPECTRAL LINES OF He I AND He II BY THE EXCITATION OF He^+ ATOMS IN A VAN DE GRAAFF ACCELERATOR. Bashkin, A.; Beauchemin, G. (Laval Univ., Que.). Can. J. Phys., 44: 1603-7 (July 1966). (In French).

The fast beam-foil technique was used to excite various levels in He I and He II, and three spectral lines in He I and six in He II were observed. Three of the He II lines exhibit peculiar intensity patterns. (auth)

34087 CALCULATION OF THE ISOTOPIC DISPLACEMENT OF THE GROUND LEVEL OF THE ARC SPECTRUM OF ^{140}Ce AND ^{142}Ce. Champeau, Rene-Jean; Gerstenkorn, Simon (CNRS, Bellevue, France. Commissariat a l'Energie Atomique, Paris). Compt. Rend., Ser. B, 262: 1381-4(May 23, 1966). (In French).

The isotopic displacements of the 15 ground levels of Ce 1 were deduced from the high resolution analysis of the arc lines of cerium. The results obtained were interpreted using theoretical data on this spectrum and by using the relations on the screening effects. It is found that the effects of the specific mass in the case of the isotope couple considered is not very high, of the order of 10 mK. (tr-auth)

34088 MEASUREMENT OF POPULATION TRANSFER BETWEEN THE TWO HYPERFINE LEVELS OF THE 6^3P_1 STATE OF ^{199}Hg UNDER THE EFFECTS OF COLLI-

SIONS BETWEEN HELIUM ATOMS. Faroux, Jean-Pierre (Ecole Normale Superieure, Paris). Compt. Rend., Ser. B, 262: 1385-8(May 23, 1966). (In French).

One of the hyperfine levels was excited selectively. This excitation is modulated by affecting the nuclear magnetic resonance of ^{199}Hg in the ground state 6^1S_0. The population transfer between hyperfine levels is deduced from the measurement of the modulation amplitudes of the fluoresence light of each level. It is compared with theoretical predictions. (tr-auth)

34089 MEASUREMENT OF THE ISOTOPIC DISPLACEMENT IN THE ARC SPECTRUM LINES OF ^{140}Ce AND ^{142}Ce. Champeau, Rene-Jean; Gerstenkorn, Simon; Glueck, Gilbert (CNRS, Bellevue, France). Compt. Rend., Ser. B, 262: 1429-31(June 1, 1966). (In French).

The isotopic displacements of some 100 lines of the arc spectrum of cerium were measured using the photoelectric Fabry-Perot spectrometer. Displacements higher than 70 mK were detected and these large isotopic displacements can be attributed without possible doubt to lines of the arc spectrum. The precision of the measurements is of the order of 2%. (tr-auth)

34090 FINE STRUCTURE ANALYSIS OF $^{63}Cu\ ^{127}I$ BANDS. Ramakoteswara Rao, P.; Appa Rao, K. V. S. R. (Atomic Energy Establishment, Trombay, Bombay). Curr. Sci. (India), 35: 299-300(June 20, 1966).

Results of fine structure analysis of the bands of $^{63}Cu^{127}I$ molecules (natural CuI consists of two isotopic species $^{63}Cu^{127}I$ (69%) and $^{65}Cu^{127}I$ (31%)) are presented. (B.G.D.)

34091 INTERACTIONS BETWEEN THE HYDROGEN ISOTOPES AND THEIR ORTHO AND PARA MODIFICATIONS. Knaap, H. F. P.; Hermans, L. J. F.; Jonkman, R. M.; Beenakker, J. J. M. (Kamerlingh Onnes Laboratorium, Leiden). Discuss. Faraday Soc., No. 40, 135-9 (1965).

Measurements were performed on the differences in dielectric constant between gaseous H_2, HD, and D_2 at 77.3°K and between normal H_2 ($^3/_4$ ortho and $^1/_4$ para) and para H_2 at 20.4°K. From these experimental data the differences in electric polarizability were calculated. The obtained values agree well with earlier theoretical estimates. (auth)

34092 OPTICAL ABSORPTION SPECTRA OF SILVER ATOMS STABILIZED IN DIFFERENT MATRICES AT 77 DEG K. Zhitnikov, R. A.; Mel'nikov, N. I. (Ioffe Physicotechnical Inst., Leningrad). Dokl. Akad. Nauk SSSR, 166: 1326-7(Feb. 21, 1966). (In Russian).

The first results are reported of an investigation of the optical absorption of stabilized silver atoms, which were obtained earlier (Fiz. tverd. tela v. 7, 1965) by x-ray irradiation of frozen alcohol and water solutions of silver salts. The alcohol solutions were frozen by immersing a quartz test tube with solution directly in the liquid nitrogen, while the aqueous solutions were obtained by first freezing in a household refrigerator and then dropping the frozen samples in liquid nitrogen. Both the irradiation and spectral measurements were made at 77K. The spectra disclose two lines connected with the transitions $^2S_{1/2}\ ^2P_{1/2}$ and $^2S_{1/2}\ ^2P_{3/2}$ in the free neutral atoms of silver. The spectra obtained with different matrices exhibit great similarity, but still disclose certain differences between the matrices. The wavelengths and the half-widths of the different spectral lines are listed in a table. Stabilization produces several doublets and triplets in individual spectra. The presence of the doublets and triplets is probably connected with the stabilization of the silver atoms in several different capture places present in a single matrix. The presence of such different types of capture places was already established in the earlier investigation. Certain theoretical explanations for the line splitting are proposed, but quantitative deductions must await further data obtained with the aid of paramagnetic resonance. (ATD)

34093 PATH AND PROBABILITY OF YIELD OF SLOW ELECTRONS FORMED BY PASSAGE OF β PARTICLES THROUGH A HYDROCARBON MEDIUM. Fleisher, V. G. (Ioffe Inst. of Physics and Tech., Leningrad). Fiz. Tverd. Tela, 8: 616-19(Feb. 1966). (In Russian).

The source of slow electrons at the surface of a hydrocarbon medium was prepared either by use of labeled monocetyl phosphate, which is surface active and contains ^{32}P at the hydrophilic end, or by use of an auxiliary source of a collimated beam of electrons. The yield of particles is then a function of the angle of the path of the electron and the normal to the surface. This may be converted to an overall yield probability over all distances from the source which is evaluated from the second type of source. The combined probability of traveling a distance and probability of yield at the electron surface may then be evaluated. When this is plotted against the number of monolayers separating the active atoms from the surface, a curve consisting of two exponential terms is found. One of these is a constant with respect to number of monolayers and the other is related to the mean path. The overall yield probability is $(1.9 \pm 0.1) \times 10^{-2}$ for an angle of $\pi/4$, giving a yield probability of $(5.4 \pm 0.9) \times 10^4$ electrons/cm. The probability of transit across the potential barrier at the surface is calculated from this to be 0.65 ± 0.11. (BBB)

34094 INTERMOLECULAR-POTENTIAL-ENERGY CURVES: THEORY AND CALCULATIONS ON THE HELIUM-HELIUM POTENTIAL. Kestner, Neil R. (Stanford Univ., Calif.); Sinanoglu, Oktay. J. Chem. Phys., 45: 194-207(July 1, 1966).

Calculation of intermolecular-potential-energy curves by the application of the many-electron theory of atoms and molecules is outlined. The interaction is split into a Hartree–Fock and a correlation part. Both parts are given both in localized and in MO descriptions. Most of the interaction is calculated directly, not by difference of total energies. The correlation part involves only two-electron variational equations. These results are then used to obtain the many-electron contributions. To examine the method and estimate the magnitude of the various contributions, the helium–helium interaction is calculated for distances over 4.5 a.u. (experimental minimum about 5.5 a.u.) using a very simple localized molecular wavefunction based on single Slater atomic orbitals. The correlation-energy contribution is calculated with the Hirschfelder–Linnett pair function previously used for hydrogen interactions. Many electron and distortion effects contribute 29% of the correlation part at the potential minimum (R_e) and 23% at large distances. Like and unlike spin pairs differ in energy by about 6% at R_e. A serious correction for $R < R_e$ is the change in atomic correlation due to distortion. The total potential obtained has the correct behavior [minimum of 4.32°K at 3.04 A. (5.75 a.u.) with a long-range behavior of $-0.853R^{-6}$ in atomic units]. At short distances ($R < R_e$) the molecular orbital (MO) form of the theory becomes more convenient since the interorbital MO pair correlations are large and have some intra-atomic correlation character. The MO pair correlations approach $\epsilon(1\sigma_g^2) = \epsilon(1\sigma_u^2) = \epsilon(1\sigma_g\alpha 1\sigma_u\beta) = \frac{1}{2}\epsilon(\mathrm{He}) = -0.57$ eV as $R \to \infty$. The LO description is used for $R \gtrsim R_e$. (auth)

34095 RADIATIVE RECOMBINATION IN CESIUM. Norcross, D. W.; Stone, P. M. (Sperry Rand Research Center, Sudbury, Mass.). J. Quant. Spectros. Radiative Transfer, 6: 277-90(May-June 1966).

Cross sections for radiative recombination of slow electrons (≤1 ev) with singly charged cesium ions were calculated, using an adjusted form of the Quantum Defect Method (QDM). The QDM was empirically adjusted so that oscillator strengths for transitions to high bound states agree with carefully calculated f values previously obtained for cesium. The adjustment of QDM is discussed and the adjustment parameters for the twenty lowest states of cesium are presented. The resulting cross sections and radiative recombination coefficients for electron temperatures from 1000 to 3400°K are tabulated. Deviations from experimental cross sections for recombination into the 6S and 6P levels are observed. Photoionization cross sections may also be obtained from the data presented. (auth)

34096 RESONANCES IN NEUTRAL BREMSSTRAHLUNG. Kivel, B. (Avco-Everett Research Lab., Everett, Mass.). J. Quant. Spectros. Radiative Transfer, 6: 369-70(May-June 1966).

It is pointed out that the possibility of resonances should be considered in estimating bremsstrahlung. In particular, the intensity of the well-known resonance in the elastic scattering cross section of low energy electrons by molecular nitrogen is estimated in a manner analogous to a transition between two bound states. It is found that a strong resonance transition in molecular nitrogen may enhance the spectral radiation moderately in the neighborhood of 1μ. (auth)

34097 PROTON SPIN-LATTICE RELAXATION IN LIQUID WATER AND LIQUID AMMONIA. Smith, D. W. G.; Powles, J. G. (Univ. of Kent, Canterbury, Eng.). Mol. Phys., 10: 451-63(1966).

The proton spin-lattice relaxation time was measured at 20.8 Mc for a series of solutions of water in heavy water and solutions of ammonia in heavy ammonia for the temperature range from the melting point to the liquid-vapor critical temperature. Measurements were also made for water over limited temperature ranges at several fixed densities. (auth)

34098 ISOTOPE SHIFTS IN THE NEAR INFRARED BANDS OF DIATOMIC SULFUR. Narasimham, N. A.; Apparao, K. V. S. R. (Atomic Energy Establishment, India). Nature, 210: 1034-5(June 4, 1966).

Two systems of near infrared bands of the isotopic molecules, ^{32}S, $^{32}S_2$, ^{34}S, and $^{34}S_2$ were obtained. Vibrational and rotational analyses of these bands confirmed that the emitter of the near infrared bands is the diatomic sulfur molecule. The isotope shifts provided a correct vibrational assignment of the bands in both systems. The 0–1, 0–2, 0–3, bands, due to ^{32}S, ^{34}S, and $^{34}S_2$, showed progressively larger shifts toward the shorter wavelength side of $^{32}S_2$ bands. (J.G.B.)

34099 NONCOMPACT EXTENSIONS OF SYMMETRY GROUPS. Budini, P. (International Centre for Theoretical Physics, Trieste). Nuovo Cimento (10), 44A: 363-73(July 21, 1966).

A method is proposed for the determination of the energy spectrum of a quantum-mechanical system with algebraic methods based on the knowledge of its symmetry properties. The proposed method is applied to simple maximal degenerate systems like the harmonic oscillator and the hydrogen atom. For the latter the generators of the SO(4, 1) dynamical algebra are explicitly given. (auth)

34100 MAXIMAL DEGENERATE SYSTEM DYNAMICS. Bisiacchi, A.; Budini, P. (International Centre for Theoretical Physics, Trieste). Nuovo Cimento (10), 44A: 418-26(July 21, 1966).

It is shown that for a "maximally degenerate" system for which the energy multiplet builds up a most degenerate representation of the symmetry group, the dynamical problem can be solved with purely group-theoretic methods once the spectrum-generating algebra is known. The Casimir operator of this algebra can be reduced in terms of a Cartan operator of the symmetry algebra (eventually of the UEA) and of its Casimir operator; this fixes the energy spectrum, the dynamical equations and Green functions for the system. The method is applied to the N-dimensional harmonic oscillator for which Sp(N, R) is the spectrum-generating algebra. (auth)

34101 CALCULATION OF THE VIBRATIONAL SPECTRA OF MONOGERMANE. Ponomarev, Yu. I. Opt. Spectros. (USSR) (Engl. Transl.), 20: 124-5(Feb. 1966). Translated from Opt. Spektros., 20: 230-3(Feb. 1966).

The force constants of monogermane are calculated on the basis of the frequencies and the Coriolis constants ζ_1 of the GeH_4 and GeD_4 molecules. The results obtained are applied to the calculation of the frequencies, Coriolis constants, and vibration forms of all the deuterium substitution products of this molecule. (auth)

34102 Q STRUCTURE AND K-SHELL VACANCIES IN Ne^+–Ne COLLISIONS AT 150 TO 400 kev. Kessel, Quentin C.; McCaughey, Michael P.; Everhart, Edgar (Univ. of Connecticut, Storrs). Phys. Rev. Lett., 16: 1189-91 (June 27, 1966).

It was proposed that the doubly peaked structure in the Q-values for Ne^+–Ne collisions may be due to a K-shell vacancy (caused by the collision) which is followed by emission of a fast electron with energy somewhat less than that of the K edge of neon (874 ev). This proposal was checked experimentally by making a noncoincident energy analysis of the electrons emitted in the backward direction (115°) from 200-kev Ne^+–Ne single collisions. The experiment was repeated at 400 kev using the Ne^{++}–Ne collision. A single peak was observed at an electron energy of 625 ev in the first experiment; a double peak was observed in the second, due to the larger difference in the Doppler shift. (G.O.Y.)

34103 2p → 1s X-RAY TRANSITIONS IN π-MESONIC ATOMS. Jenkins, David A.; Kunselman, Raymond; Simmons, Melvin K.; Yamazaki, Toshimitsu (Univ. of California, Berkeley). Phys. Rev. Lett., 17: 1-3(July 4, 1966). (UCRL–16855).

The 2p → 1s π-mesonic and muonic x-ray energies and widths were measured for $3 \leq Z \leq 12$ in order to study the effect of the nucleus on π-mesonic x-ray energy levels. (B.G.D.)

34104 RAMAN LINES IN COMPTON SCATTERING. Faessler, A.; Muehle, P. (Univ., Munich). Phys. Rev. Lett., 17: 4-5(July 4, 1966).

Observation of discrete lines in the spectrum of modified x radiation scattered by light elements, previously announced by Das Gupta, is reported. The lines are on the long-wavelength side of the Rayleigh lines, the energy difference being independent of the scattering angle and equal to the excitation energy of the scattering angle. The experiment was carried out with $CuK_{\alpha_{1,2}}$ radiation and beryllium and boron as scattering materials. (B.G.D.)

34105 COMPARISON OF THICK-TARGET ELECTRON BREMSSTRAHLUNG INTENSITY MODELS WITH EXPERIMENT. Yucker, W. R.; Lilley, J. R. (Douglas Aircraft Co., Inc., Santa Monica, Calif.). Trans. Amer. Nucl. Soc., 9: 105-6(June 1966).

34106 TRANSITION PROBABILITIES IN THE ELECTRON AND VIBRATIONAL SPECTRA OF HYDROGEN MOLECULES. Geiger, J.; Topschowsky, M. (Technische Univ., Berlin). Z. Naturforsch., 21a: 626-34(May 1966). (In German).

The energy loss spectrum of electrons interacting with molecular hydrogen (natural and para hydrogen) was measured by means of a high resolution technique recently developed. The primary energy was 30 kev, the energy resolution 0.01 ev. The spectra clearly show the rotational structure. Franck-Condon overlap integrals were computed for the Lyman and Werner bands using the WKB method and Namioka's potential curves. The experimental band intensities agree with these theoretical values much better than with Franck-Condon factors obtained from Morse functions. Some small discrepancies for the Lyman bands may be referred to the dependence of the electron transition moment on the nuclear distance. In contrast to ultraviolet absorption spectra the predissociation edge at 14.7 ev could not be observed in the energy loss spectra. (auth)

34107 HYPERFINE STRUCTURE OF $3^2P_{\frac{1}{2}}$ STATE OF SODIUM IN A STRONG MAGNETIC FIELD. Ackermann, Hans (Univ., Tuebingen, Ger.). Z. Phys., 194: 253-69 (1966). (In German).

The hyperfine structure of the $3^2P_{\frac{1}{2}}$ state of Na^{23} was measured by the optical double resonance technique in a magnetic field of 3.1 kG sufficiently strong to decouple completely I and J. In the case of π or $(\sigma^+ + \sigma^-)$ excitation the double resonance signal represents the superposition curve of eight unresolved radio-frequency transitions. The dependence of the signal on the pressure of sodium vapor and the radio-frequency field strength was studied. The analysis of the experimental curves yields for the hyperfine coupling constants the values a = (18.7 ± 0.4) Mc/s and b = (3.4 ± 0.4) Mc/s. The nuclear electric quadrupole moment derived from the ratio of b/a is Q = $(0.146 \pm 0.02) \cdot 10^{-24}$ cm². The Landé factor and the life-

time for the $3^2P_{\frac{1}{2}}$ state are $g_J = 1.3344 \pm 0.0004$ and $\tau = (1.61 \pm 0.07) \cdot 10^{-8}$ sec. (auth)

34108 HYPERFINE STRUCTURE OF EXCITED $3^2P_{\frac{1}{2}}$ STATES OF SODIUM. Baumann, M.; Hartmann, W.; Krueger, H.; Oed, A. (Univ., Tuebingen, Ger.). Z. Phys., 194: 270-9(1966). (In German).

The hyperfine structure of the $3^2P_{\frac{1}{2}}$-state in the Na(I)-spectrum was investigated by optical double resonance. Three zero field rf-transitions ($\Delta F = \pm 1$, $\Delta m_F = 0$) were detected and thus the unambiguous interpretation of the rf-spectrum was made possible. From an analysis of the rf-spectrum one obtains the magnetic hyperfine structure splitting constant $a = (18.5^{+0.6}_{-0.2})$ Mc/sec and the electric quadrupole interaction constant $b = (3.2 \pm 0.5)$ Mc/sec, which yields an electric quadrupole moment $Q(^{23}Na) = (0.138 \pm 0.025) \cdot 10^{-24}$ cm^2. (auth)

34109 NEGATIVE MUON CATALYSIS OF THE NUCLEAR REACTIONS $d\mu + p \rightarrow {}^3He + \mu^-$ AND $d\mu + d \rightarrow t + p + \mu^-$ AND $pd\mu$ AND $dd\mu$ MOLECULE FORMATION IN GASEOUS HYDROGEN. Dzhelepov, V. P.; Ermolov, P. F.; Moskalev, V. I.; Filchenkov, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 50: 1235-51(May 1966). (In Russian).

The yields of nuclear reactions (1) $d\mu + p \rightarrow pd\mu \rightarrow {}^3He + \mu^-$ and (2) $d\mu + d \rightarrow dd\mu \rightarrow p + t + \mu^-$ were measured with a diffusion cloud chamber filled with hydrogen and deuterium at 7–23 atm. The muon transfer rate from the $d\mu$-atom to carbon and oxygen was found from experimental $d\mu$-atom range distributions and Auger electron yields. The formation rates of the $pd\mu$ and $dd\mu$ molecules (reduced to the density of liquid hydrogen and deuterium) were found to be $\lambda_{pd\mu} = (1.8 \pm 0.6) \cdot 10^6$ sec^{-1}, $\lambda_{dd\mu} = (0.75 \pm 0.11) \cdot 10^6$ sec^{-1}. The estimate of the relative yield of the reaction (3) $d\mu + d \rightarrow dd\mu \rightarrow t\mu + p$ provides that $Y(3)/Y(2) < 0.14$ with a 90% probability. The analysis of experimental data on reactions (1) and (2) allows a conclusion that the resonance mechanism of $dd\mu$-molecule formation and the nuclear reaction inflight is likely to be the reason of the large yield of the two deuteron fusion reactions under the conditions of our experiments. (auth)

34110 EXPERIMENTAL INVESTIGATION OF THE EFFECTIVE CROSS SECTIONS FOR DESTRUCTION AND FORMATION OF FAST NEGATIVE IONS IN ATOMIC COLLISIONS. Dmitriev, I. S.; Nikolaev, V. S.; Teplova, Ya. A.; Popov, B. M.; Vinogradova, L. I. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 50: 1252-9(May 1966). (In Russian).

The effective cross sections for loss of one, two, or three electrons in helium, nitrogen or argon are measured for negative carbon, nitrogen and oxygen ions produced as a result of charge exchange of positive ions accelerated in a 72 centimeter cyclotron to a velocity $v = 2.6 \cdot 10^8$ cm/sec. The cross section for simultaneous loss of two electrons by negative ions is about 50 to 70% of the cross section for loss of a single electron. Comparison of the results obtained with with the known cross sections for electron loss by other negative or positive ions shows that the specificity of negative ions expressed in the weak coupling of the outer electron with the ion frame, does not appreciably affect the interaction between the negative ions and matter at a velocity $v = 2.6 \cdot 10^8$ cm/sec. Data on the cross sections for formation of negative ions as a result of capture of two electrons by positive ions or capture of an electron by neutral atoms are obtained for carbon and oxygen. Equilibrium values of the fraction of negative carbon or oxygen ions in a beam passing through a sufficiently thick layer of matter (Φ_{-1}) is obtained. Maximal values of Φ_{-1} obtain in media in which the cross sections for formation of negative ions with a given velocity attain maximum. (auth)

34111 IONIZATION OF ATOMS IN AN ALTERNATING ELECTRIC FIELD. Perelomov, A. M.; Popov, V. S.; Terentev, M. V. Zh. Eksp. Teor. Fiz., 50: 1393-1409 (May 1966). (In Russian).

A method is developed for calculating the probability for ionization of the bound state under the action of an alternating electric field. The method is valid under the conditions $F \ll F_0$, $\omega \ll \omega_0$ (ω and F are the frequency and amplitude of the external field, $\omega_0 = \varkappa^2/2$ and $F_0 = \varkappa^3$ are the respective atomic quantities). The quasiclassical nature of the motion of a particle in a homogeneous electric field is exploited in the method which extends the usual quasiclassical approximation to the nonstationary case. The adiabatic approximation in the ionization problem is first considered (for a frequency range $\omega \ll \omega_t$, where $\omega_t = F/\varkappa$ is the tunnel frequency). Formulas for the probability for ionization of an arbitrary atom by the field of a plane or elliptically polarized wave are derived. The model problem of ionization of a bound state in a one dimensional δ potential is investigated in detail for arbitrary values of the ⟨⟨adiabaticity parameter⟩⟩ $\gamma = \omega/\omega_t$. Formulas are derived for the probability of ionization of an arbitrary bound state under the action of a varying electric field. The cases of plane and circularly polarized electromagnetic waves are considered (Coulomb interaction between the electron and remainder ion at large distances ($\varkappa r \gg 1$) is neglected). The total ionization probability can be expressed as the sum of multiphoton processes. In the low frequency limit ($\omega \ll \omega_t$) the formulas obtained go over to those of the adiabatic approximation. (auth)

34112 CHARGE EXCHANGE OF ALKALI METAL IONS IN COLLISIONS WITH GAS ATOMS AND MOLECULES. Ogurtsov, G. N.; Flaks, I. P.; Kikiani, B. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 36: 491-6(Mar. 1966). (In Russian).

The charge exchange cross sections of 1 to 30 kev Li^+, Na^+, K^+, and Cs^+ ions on Ne, Ar, Kr, and Xe atoms and H_2 and N_2 molecules were measured by a single collision technique. The ion beam passed through the collision chamber containing the target gas at a pressure of about 1.5×10^{-4} Hg and was swept clear of charged particles by an electrostatic field. The neutral particles remaining in the beam were received in a Faraday cup and their flux was determined from the secondary electron emission to which they gave rise. A background flux measured with the collision chamber empty was subtracted from the measured flux before the cross section was computed. The geometry was such that particles scattered through angles less than 5° would be recorded. It is estimated that at energies below 3 kev, loss of particles from the beam by scattering may have resulted in underestimation of the cross section by as much as 20%. All the measured charge exchange cross sections increased with increasing relative velocity of the colliding particles, as would be expected on the basis of the adiabatic hypothesis in view of the large energy defects. The cross sections at 30 kev ranged from 10^{-17} to 3×10^{-16} cm^2. The cross sections of the different alkali metal ions on the same target gas and for the same relative velocity increased with increasing mass of the ion, even though the energy defects are greater for the heavier ions. This phenomenon is explained as a result of the greater polarizability of the heavier alkali metal atoms. The present results are in good agreement with those of N. V. Fedorenko for Na^+ on Ar and with those of S. K. Allison, J. Cuevas, and M. Garcia-Munoz for Li^+ on N_2 but there are large discrepancies between the present results and other data in the literature. (ATD)

34113 PRESSURE EFFECTS ON THE VIBRATION-ROTATION SPECTRUM OF HYDROGEN. Brannon, Paul Jerry. Ann Arbor, Mich., Univ. of Michigan, 1965. 111p.

Thesis.

Pressure effects on the vibration-rotation energy levels of the hydrogen molecule were studied by means of the electric-field-induced spectra. In the fundamental vibrational band for H_2, 6 Q, 4 S, and 3 O lines were observed; for D_2, 7 Q, 4 S, and 2 Q lines; and for HD only 5 Q, 3 S, and 1 O lines because of a limited supply of that gas. Several Q lines of the overtone were also observed for each. The line positions of H_2 and D_2 were measured at pressures between 3 and 35 atmospheres, and in this range a linear dependence of the shifts with density was compatible with the observations. The molecular constants of H_2 and D_2 were derived from the line positions extrapolated to zero

pressure by a least squares fit. The widths of the various Q, S, and O lines of H_2 and D_2 were also measured. These were compared to values calculated from Van Kranendonk's theory of the pressure broadening of the Raman spectrum lines based on an Anderson-type impact theory with a quadrupole-quadrupole interaction. The calculated values were corrected for Doppler broadening, and then modified to include the effect of the finite spectral band pass of the spectrometer, which was assumed to be of gaussian shape. The line widths calculated in this manner were in fair quantitative agreement with those measured. (Dissertation Abstr.)

34114 APPARATUS RESOLUTION AND MEASURED SCATTERING CROSS SECTIONS. Christian, Larry Omar. Tucson, Ariz., Univ. of Arizona, 1966. 115p.

Thesis.

The molecular-beam method was used to determine the effect of apparatus resolution on the measured cross sections of a full thermal cesium beam scattered by the five scattering gases, He, Ne, Ar, Kr, and Xe. The variation of "partial" total cross sections was measured as a function of the angular resolution of the apparatus (using the Kusch 50% criterion) over the range from 12 to 120 seconds of arc. The accuracy of these relative measurements was within ±5%. The experiments showed that extremely large discrepancies (a range of approximately a factor of three) in the Cs-He total cross section reported by previous investigators cannot be explained by the differences in resolution employed by these workers. It was found that the cross sections for a Cs beam scattered by He, Ne, Ar, Kr, and Xe decreased by 11.5, 10.5, 16, 13, and 15 percent, respectively, as the resolution was varied over the experimental limits employed. As a by-product of the present work, the "true" total cross sections (with an error of ±25%) for the cases Cs-He, Cs-Ne, and Cs-Ar were obtained by extrapolation of the results to zero resolution. The van der Waals constant, C, was calculated (using the Schiff-Landau-Lifshitz theory and an interatomic potential of the form $V(r) = -C/r^6$) for these three cases. (Dissertation Abstr.)

34115 THEORETICAL INVESTIGATION OF DOUBLY AND TRIPLY-IONIZED LANTHANIDES, AND THE EMPIRICAL ANALYSIS OF Er III. Becher, Jacob. Baltimore, Johns Hopkins Univ., 1965. 203p.

Thesis.

General methods devised by Racah, Judd, and others were used to obtain the energy levels for configurations of the type $f^n p$ and $f^n d$ for a number of spectra of the doubly ionized lanthanides. Configuration interactions were ignored and in the case of n greater than 3, only the lower part of each configuration was considered. In the case of n = 4 and n = 10, only the states belonging to $f^n(^3I)$ were examined, whereas in the case of n = 5, 6, 8, 9, all f^n states having highest multiplicity were taken into account. In addition, an extensive Er III line list with an estimated accuracy of ±.05 cm^{-1} was compiled. With the use of this line list, an initial analysis yielded most of the levels pertaining to $f^{11}(^4I)$ with an added s, p, and d electron. (Dissertation Abstr.)

34116 ATOMIC EJECTION IN THE BEAM SPUTTERING OF NICKEL, BY ARGON IONS, IN THE THRESHOLD TO 600 ev ENERGY RANGE. Cuderman, Jerry Ferdinand. Corvallis, Oreg., Oregon State Univ., 1966. 121p.

Thesis.

A low-energy, three-stage, differentially pumped ion accelerator similar to that used by Hagstrom for Auger electron ejection studies and radiotracer methods were used to study low-energy sputtering. The experimental approach consisted of pumping down the experimental tube to 10^{-9} torr, outgassing the target by electron bombardment, introducing argon into the system, and bombarding a ^{63}Ni target for a time that is short compared to the time required for a monolayer of adsorbed gasses to form at the existing residual partial pressure of adsorbable gases. Heating the target above its recrystallization temperature produced an 80 percent oriented polycrystalline surface, which approximated the (100) plane of a nickel single crystal. Sputtered atoms were collected on a removable molybdenum foil. After each bombardment, the molybdenum foil was removed and cut into narrow strips, and the strips were analyzed by placing them under a G-M counter. The tracer technique permitted measuring the relative sputtering yields from individual crystallographic directions with respect to the angle of incidence of the ion beam. There was very little dependence of the threshold on angle of ion incidence with respect to a given chain direction. The observed sputtering yield curves flattened out or "saturated" at a much lower energy than those appearing in the literature. The saturation yield proved highly dependent on the angle of ion incidence. Reflection maxima of sputtered nickel atoms, which appeared behind the target on the collector surface, appear to be due to specular reflection from the primary maxima. A plot of the reflection ratios as a function of incident ion energy suggests that the specular reflection arises from resonance scattering from the interaction potential that the nickel atoms encounter at the molybdenum surface. (TCO)

34117 THEORY OF RESONANT ELECTRON CAPTURE IN He^+ ON He COLLISIONS. Hilsinger, Harold Wheeler. Storrs, Conn., Univ. of Connecticut, 1965. 120p.

Thesis.

The collision between a helium atom and a helium ion is described using the impact parameter method. A transformation from fixed to rotating coordinates is used in which the quasi-molecule, formed by the atom and ion, is attached to the rotating system. A set of LCAO molecular orbitals is defined in the rotating system and the eigenenergies of an electron in these static molecular orbitals is calculated. These molecular orbitals together with a plane wave are used to construct one-particle wave functions, which better describe the collision problem than would the molecular orbitals alone. The total three-particle wave function is an expansion in terms of Slater determinants of the one-particle wave functions, the coefficients of which are time dependent. The coefficients are known before collision and their time variation during collision is described by a set of coupled differential equations derived from the time-dependent Schroedinger equation. It is shown that there exist excited states that couple directly to the initial ground state through the hamiltonian and that these excited states are due to the effect of the rotation of the molecule. It is shown how the effect of relative motion along the internuclear line may be ignored while the effect of the rotation may be retained. Finally, the probabilities of charge exchange and excitation are written in terms of the time-dependent coefficients evaluated after the collision. (Dissertation Abstr.)

34118 THEORETICAL INVESTIGATION OF ELECTRON MOLECULE SCATTERING. Peacher, Jerry Lee. Bloomington, Ind., Indiana Univ., 1965. 77p.

Thesis.

The effect of temperature on the electron diffraction pattern of a diatomic molecule is considered using a Morse potential, V(r). The quantity, $V(r) + [\hbar^2 J(J+1)/2\mu r^2]$, is expanded about its minimum and a second-order wave function is obtained by treating the higher order terms in the expansion as a perturbation. Using this second-order wave function and performing a statistical average, explicit temperature-dependent expressions are obtained for the diffraction parameters r_s and l_s^2. Some results are presented for T = 300° and 1500°K. Also a temperature-dependent expression for M(s) is obtained using only the first-order wave function. The phase amplitude method is used to reduce the radial Schroedinger equation to two separate differential equations, one for the phase and one for the amplitude. These functions are both smooth as opposed to the rapidly oscillating solution to the radial Schroedinger equation. The partial wave phase shifts were obtained rapidly by integrating the differential equations for the the phase and amplitude numerically. Hartree-Fock and Thomas-Fermi-Dirac fields were used in the calculation. Thus the phase amplitude method was used to obtain a rapid method of computing partial wave phase shifts numerically. It was found that the WKBJ approximation to the partial wave phase shift is a good approximation for

the energies used in electron diffraction. Also a rapid method of computing atomic scattering amplitudes was obtained. In the case of diatomic molecules the accurate atomic scattering amplitudes coupled with the explicit temperature dependence of the diffraction parameters would allow one to obtain estimates of the parameters characterizing the potential function. (Dissertation Abstr.)

34119 POLARIZED ELECTRON SOURCE FOR HIGH ENERGY ACCELERATORS. Hughes, V. W.; Long, R. L. Jr.; Posner, M.; Raith, W. (Yale Univ., New Haven). 10p. (CONF-650653-17). ORAU. Gmelin, AED-CONF-65-170-30.

From American Physical Society, Summer Meeting, New York.

The method of production of a source of polarized electrons, suitable for injection into accelerators, by photoionization of a polarized atomic beam of potassium, is discussed. (B.G.D.)

34120 BUBBLE (VAPOR) PRODUCTION BY LINAC ELECTRONS IN LIQUID-HYDROGEN AND DEUTERIUM TARGET. Kaiser, H. F. (Naval Research Lab., Washington, D. C.). 10p. (CONF-650653-18). ORAU. Gmelin, AED-CONF-65-170-29.

From American Physical Society, Summer Meeting, New York.

The amount of vapor produced transiently or permanently during electron scattering experiments with liquid gases as targets is discussed. (B.G.D.)

34121 OBSERVATION OF LEVEL CROSSING IN D, n = 2. Robiscoe, R. T. 11p. (CONF-660107-36). ORAU. Gmelin, AED-CONF-66-003-59.

From American Physical Society Meeting, New York.

A beam experiment is discussed which is designed to measure the Lamb shift in the n = 2 state of atomic hydrogen and deuterium. (B.G.D.)

Cosmic Radiation

See also Elementary Particles and Radiations
Nuclear Properties and Reactions

Refer also to abstracts 34059, 34062, 34063, and 34394.

34122 (N-66-12247) PION PRODUCTION IN HIGH-ENERGY COSMIC-RAY COLLISIONS. Spergel, Martin S.; Lieber, M.; Milford, S. N. (Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.). June 1965. Contract NASw-699. 43p. (NASA-CR-68092; RE-215J). CFSTI $2.00 cy, $0.50 mn.

The Landau-Milekhin hydrodynamic model of very high energy nucleon interactions is extended to calculate the pion energy and angle distributions in the center of mass system and laboratory frames. Consideration of the physical limitations on the average energy of the pions produced in the decomposition of the nucleonic fluids leads to truncation of the pion distribution and a rather slow energy dependence of the average c.m.s. pion energy on the incident proton energy. When a power law dependence is chosen for incident primary cosmic ray protons, the pion production spectrum found in the laboratory frame has a steeper energy spectrum than those found using simpler models of nucleon interactions. (auth)

34123 (N-66-12961) HIGH-ENERGY PHOTONS AND NEUTRINOS FROM COSMIC SOURCES. Gould, R. J.; Burbidge, G. R. (California Univ., La Jolla, San Diego). Apr. 1, 1965. 95p. (NASA-CR-68298). CFSTI $3.00 cy, $0.75 mn.

The mechanisms which give rise to hard radiation in the universe are summarized. It is recognized that apart from observations of the sun, there is little observational evidence which can be used in conjunction with the theoretical estimates. It has been shown that there are sources of x-rays at flux levels which are detectable with present techniques. Moreover, the absence of a large isotropic flux of x rays permits the establishment of limits on the temperature of the intergalactic medium. The theoretical estimates of fluxes suggest that a great increase in sensitivity of detectors as well as good resolution is required to exploit this field. Finally, the x ray observations already have shown that the universe is not very hot and may in fact be rather cool. In this case, apart from the neutrino flux which is part of the general cosmological thermal radiation field, the flux of hard radiation may be rather weak. (STAR)

34124 (N-66-13638) PRODUCTION SPECTRUM OF HIGH-ENERGY ELECTRONS FROM HIGH ENERGY COSMIC-RAY COLLISIONS. Spergel, Martin S.; Scanlon, Joseph H. (Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.). June 1965. 32p. (NASA-CR-68566; RE-213J). CFSTI $2.00 cy, $0.50 mn.

The distribution of charged pions from proton-proton collisions is combined with the cosmic ray flux and the distribution of electrons from $\pi\mu e$ decay to give the production spectrum of electrons from cosmic ray collisions. The proton-proton collisions are described by the Landau hydrodynamical model. Calculations are performed for electron energies between 20 and 10^8 Bev. The electron production spectrum is seen to exhibit approximately an $E_e^{-3.3}$ behavior, where E_e is the electron energy. (auth)

34125 (N-66-14060) INVESTIGATION OF PRIMARY COSMIC RAYS ON THE "PROTON-1" SPACECRAFT. Grigorov, N. L.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A.; Skuridin, G. A. Translated from a paper presented at 16th International Astronautical Congress, Athens, September 1965. 57p. (NASA-TT-F-9794). CFSTI $3.00 cy, $0.50 mn.

The Proton-1 spacecraft and the onboard equipment for studying high- and superhigh-energy particles and the electron-photon components of primary cosmic rays are discussed. Preliminary results of the cosmic ray study conducted on the Proton-1 are presented. (B.G.D.)

34126 SPECTRAL VARIATIONS DURING COSMIC RAY STORMS. Groenkvist, B. O. (Uppsala Univ.). Ark. Geofys., 4: 513-21(1966).

Three cosmic ray storms during the IGY, which differ as to the type, were treated for a study of changes in the effective integral rigidity spectrum of the nucleon component. The time dependence of the exponent of the spectrum is illustrated for the rigidity region 11 – 18 GV with a time resolution of two hours. An analytical expression is given where changes in the effective integral spectrum are transformed into changes in the primary spectrum. The extreme values of these changes vary from one storm to another. An extension of the treatment to lower rigidities is discussed. (auth)

34127 KINETIC PROPERTIES OF THE GALACTIC COSMIC-RAY GAS. Parker, E. N. (Enrico Fermi Inst. for Nuclear Studies, Chicago. Univ. of Chicago). Astrophys. J., 144: 916-20(June 1966).

The elementary formulas for the pressure and the speed of sound in a statistically isotropic homogeneous cosmic-ray gas are worked out. Cosmic-ray observations near earth give a cosmic-ray energy density of 1.29×10^{-12} erg/cm^3, a pressure of 0.45×10^{-12} dyne/cm^2, and a compressibility $\delta P/\delta N = 0.66 \times 10^{-12}$ erg/cm^3. There is reason to believe that the interstellar values are not significantly higher than near earth. (auth)

34128 ATMOSPHERIC CONTRIBUTION TO THE DIURNAL VARIATION OF THE COSMIC-RAY MESON INTENSITY AT DEEP RIVER. Bercovitch, M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 44: 1329-47(June 1966). (AECL-2444).

The correlation between the atmospheric temperature contribution to the diurnal variation observed by a meson monitor at Deep River and the diurnal variation of two easily and continuously observable atmospheric variables, the ground-level air temperature and the barometric pressure was established. The atmospheric meson diurnal variation vector is taken to be, on a statistical basis, A = M – RN, where M and N represent the observed meson-monitor and neutron-monitor diurnal variations and R is the factor of proportionality between the meson and neutron

monitor responses to the primary anisotropy. It is found that A is proportional in amplitude to T, the ground-level temperature diurnal variation, and, further, that T and the barometric-pressure diurnal variation P are proportional in amplitude. The "best-fit" representation of A in terms of T and P is determined by minimizing the mean-square deviation between the daily vectors RN and (M − A). Where $A = C_t T + C_p P$, the best fit occurs when $C_t = -0.0052\%/°C$, $C_p = -0.038\%/mb$, R = 0.47, and the phase of T is shifted by +1.0 hour. These values apply to Deep River, where the original hourly meson data have been barometer-corrected using a coefficient of 0.16%/mb. (auth)

34129 FLARE STARS AS POSSIBLE SOURCES OF COSMIC RAYS. Gurzadyan, G. A. (Byurakan Astrophysical Observatory, Academy of Sciences, Armenian SSR). Dokl. Akad. Nauk SSSR, 166: 821-4(Feb. 1, 1966). (In Russian).

Grounds for believing that flare stars may be a source of cosmic rays lie in the appearance of the 3686 Å emission line of doubly ionized He from some flares. This means that at the time of the flare the stellar atmosphere either has ionizing radiation (shorter than 228 Å) of sufficient strength (if the ionization of He is caused by photons) or has particles (electrons) of equivalent energy (if the ionization is caused by collision). To test this, the energy distribution curves in the continuous spectrum of an M5 flare star were examined at values of μ^2 of 50 and 100 ($\mu = E/mc^2$). The value for $\mu^2 = 100$ appears very favorable. Theoretical spectra are then computed for values of μ^2 from 300 to 3000 in the x-ray range. These curves show that at $\mu^2 = 300$ (electron energy of about 10^7 ev) an appreciable proportion of the infrared quanta from the star is in the zone of x-rays ($\lambda \sim 50$ Å). With increasing μ^2 the wavelength diminishes, till at 3000 (electron energy of about 2.8×10^7 ev) the maximum is at about $\lambda = 5$ Å. Considering the distance to the flare star, it is calculated that on an average the earth may receive about 3 quanta/cm² sec from such a star, and this is within the sensitivity range of our x-ray detectors. (ATD)

34130 ANISOTROPIC COSMIC RADIATION FLUXES OF SOLAR ORIGIN. Bartley, W. C.; Bukata, R. P.; McCracken, K. G.; Rao, U. R. (Southwest Center for Advanced Studies, Dallas). Contracts NASr-198; NAS2-1756; NSR-44-004-043. J. Geophys. Res., 71: 3297-3304(July 1, 1966).

The more important features of three cosmic-ray flare effects that were observed during the first thirty days of the flight of Pioneer 6 are summarized. It was found that the cosmic radiation flux of mean energy 13 Mev/nucleon exhibited an extremely anisotropic character throughout each flare effect, the anisotropy persisting for over 48 hours during one event. The spacecraft instrumentation, the behavior of the counting rates, cosmic-ray storage at the sun, and other flare effects are considered. (J.F.P.)

34131 COLLIMATION OF COSMIC RAYS BY THE INTERPLANETARY MAGNETIC FIELD. McCracken, K. G. (Southwest Center for Advanced Studies, Dallas); Ness, N. F. Contract NSR-44-004-043. J. Geophys. Res., 71: 3315-18(July 1, 1966).

Some of the cosmic-ray and magnetic data observed by Pioneer 6 during a solar flare are compared, and specific particle guidance properties of the interplanetary magnetic field are demonstrated. It is concluded that the filaments were always connected by ordered filamentary fields to points near the sun that were never separated by more than 25° in longitude. It is thus suggested that the filamentary structure is relatively highly ordered, that is, the filaments retain approximately their same relative positions to one another in longitude despite the presence of kinks and twisting of the individual filaments. (J.F.P.)

34132 COSMIC RAY ELECTRONS AND POSITRONS. Axford, W. I. (Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.). Contract 49(638)-1537. Planet. Space Sci., 14: 652-3(July 1966).

It is shown that from the positron component of cosmic radiation it is possible to estimate both the mean confinement times of cosmic electrons and positrons in the galaxy and the mean density along their path. It is also possible to investigate the mechanisms causing solar modulation of these particles using observations of the positron-electron ratio. (J.F.P.)

Direct Energy Conversion

Refer also to abstracts 34761, 35112, and 35113.

34133 ACCELERATION INSTABILITY OF A VAPOR-LIQUID METAL INTERFACE WITH LONGITUDINAL MAGNETIC FIELD. BenDaniel, D. J.; Hurwitz, H. Jr. (General Electric Co., Schenectady, N. Y.). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1049-52(June 1966).

Liquid phase magnetohydrodynamic generators require the efficient transfer of energy from an expanding vapor to a liquid metal. A longitudinal magnetic field may influence the efficiency of this process by reducing the growth rate of the gravitational instability that is encountered. The reduction in growth rate of this instability is calculated here for arbitrary electric conductivity of the liquid. (auth)

34134 THERMIONIC ENERGY CONVERSION USING BARIUM PLUS CESIUM VAPORS. Psarouthakis, John (Martin Co., Baltimore). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1201-8(July 1966).

A concept for utilizing a low-pressure combination of barium and cesium vapors for the reduction, and preferably elimination, of transport-affected losses in thermionic energy converters was investigated. The barium vapor is introduced to modify the emitter work function, and the cesium is added to generate ions at the emitter surface for space-change neutralization. Fundamentally, the experimental data showed that the emitter work function is a unique function of the ratio T_e/T_{Ba} for the region investigated, and the cesium vapor pressures correspond very closely to those needed for ion generation at the emitter surface for neutral emission. Also, it was demonstrated that a practically collisionless operation can exist even at $d/\lambda = 4$. The "ideal-mode" characteristics showed output power densities up to 14 w/cm² at emitter and collector temperatures of 2050° and 1275°K, respectively, essentially independent of interelectrode spacing variations up to the tested spacing of 0.040 in., at an output voltage of 1.0 v and an estimated converter efficiency of 21.4%. The analysis and projection of the data show that 20 w/cm² at an estimated converter efficiency of 25% could be obtained with this approach if the collector work function can be reduced from the presently attained 2.1 ev down to 1.76 ev. (auth)

34135 OPTIMIZATION OF A MAGNETOHYDRODYNAMIC GENERATING DUCT. Carter, C. (Central Electricity Research Labs., Leatherhead, Eng.). Brit. J. Appl. Phys., 17: 863-71(July 1966).

The variation of cross-sectional area and of the electrical loading along the length of a magnetohydrodynamic generating duct is determined so as to obtain a given power output from the minimum-sized duct with a given pressure drop along the duct. The calculation uses a one-dimensional flow model of a perfect gas with constant specific heat. The electrical conductivity of the gas is assumed to obey a simple power law formula, which makes an allowance for the effect of elevated electron temperature. For combustion gases, the model indicates that the constant Mach number, constant power ratio (K = E/vB) duct is close to the optimum, but for a monatomic gas with strong elevation of electron temperature, considerable reduction in duct size is obtained by allowing K to increase along the duct. (auth)

34136 ALTERNATING-CURRENT THERMIONIC POWER DIODE WITH MAGNETIC REGENERATION. Goldstein, Arthur W.; Braun, Willis H.; Rose, James R. (Lewis Research Center, Cleveland). J. Spacecraft Rockets, 3: 927-8(June 1966).

A method of direct production of a-c power is proposed, which is believed to have less radiator, space, and weight requirements than separate inverters for d-c power generating systems. (B.G.D.)

34137 ENERGETICS 2: ELECTROGASDYNAMIC POWER. Gourdine, M. C.; Malcolm, D. H. (Gourdine Systems, Inc., Livingston, N. J.). Mech. Eng., 88: No. 7, 46-8(July 1966).

The principle, operation, and advantages of electrogasdynamic systems for power generation are discussed. (L.B.S.)

34138 EFFECT OF SIMULATED FISSION-PRODUCT GASES ON THE OPERATION OF A THERMIONIC CESIUM DIODE. Backus, C. E. (Westinghouse Astronuclear Lab., Pittsburgh); Davis, M. V. Trans. Amer. Nucl. Soc., 9: 166(June 1966).

34139 DESIGN STUDIES OF A CONVECTIVE THERMOELECTRIC GENERATOR. Shaw, David Tai-Ko; Bender, David J. (State Univ. of New York, Buffalo). Trans. Amer. Nucl. Soc., 9: 166-7(June 1966).

34140 NEW DEVELOPMENTS IN THE PRODUCTION OF ELECTRIC POWER. Allibone, T. E. Trans. Bose Res. Inst. (Calcutta), 27: No. 1, 1-12(Mar. 1964).

Developments in nuclear reactors and MHD generators for the production of electric power are discussed. The thermionic generator for the direct generation of electricity in a nuclear reactor is also discussed. The principles behind the developments mentioned or proposed are described. (P.C.H.)

34141 THERMIONIC CONVERTERS OPERATING IN THE IGNITED MODE. PART II. A QUASI-EQUILIBRIUM MODEL FOR THE INTERELECTRODE PLASMA. Wilkins, Daniel R.; Gyftopoulos, Elias P. (Massachusetts Inst. of Tech., Cambridge, Mass.). 39p. (CONF-651049-12). ORAU. Gmelin, AED-CONF-65-323-16.

From IEEE Thermionic Conversion Specialist Conference, San Diego, Calif.

A multi-stage ionization-recombination model is proposed to describe the formation and loss of atomic ions in low energy cesium plasmas. Solutions of the ambipolar diffusion equation are investigated with due consideration given to these processes. The solutions indicate the existence of a state of quasi-equilibrium throughout most of a low energy plasma in which the electron temperature is more than several hundred degrees above a critical ignition temperature. The assumption of quasi-equilibrium in the interelectrode plasma of a thermionic converter operating in the collisional ignited mode is shown to result in a plasma model which correlates a wide variety of experimental data. Included in the successful correlations are electron random current density and temperature profiles as well as output current characteristics. The experimentally observed state of quasi-equilibrium in thermionic converter plasmas is found to be near the Saha-equilibrium limit. It is therefore concluded that the multistage ionization-recombination processes in these plasmas involve numerous excited states. (auth)

34142 THERMIONIC CONVERTERS OPERATING IN THE IGNITED MODE. PART I. THEORETICAL OUTPUT CURRENT CHARACTERISTICS. Wilkins, Daniel R.; Gyftopoulos, Elias P. (Massachusetts Inst. of Tech., Cambridge). 17p. (CONF-651049-13). ORAU. Gmelin, AED-CONF-65-323-17.

From IEEE Thermionic Conversion Specialist Conference, San Diego, Calif.

Output current characteristics of thermionic converters are derived without reference to specific elastic and inelastic collision mechanisms, and are expressed in terms of arbitrary plasma electron density and temperature profiles. The general expression for the characteristics indicates that for a given current the output voltage is composed of two parts: a reference output voltage which depends only upon the output current and electrode properties and contains implicitly the effect of electron-electron collisions, and a plasma voltage loss which depends only upon certain average properties of the interelectrode plasma. It is shown that conceptually different models for the interelectrode plasma can lead to similar estimates for the plasma voltage loss and to agreement with experimental output current characteristics. For this reason, it is concluded that the successful correlation of experimental output current-voltage data is necessary but not sufficient to test the validity of a given model for the interelectrode plasma. (auth)

34143 NUCLEAR MAGNETOHYDRODYNAMIC GENERATOR. McLafferty, George Hoagland (to United Aircraft Corp.). German Patent 1,215,827. May 5, 1966. Priority date July 22, 1960, United States.

The magnetohydrodynamic generator comprises a casing providing a duct having an inlet and outlet, means for moving a fluid stream through the duct, the fluid stream including a fissionable material dispersed therethrough, moderator means surrounding the duct and extending a predetermined distance along the path of fluid flow, and electrode means positioned in contact with the fluid and in substantially juxtaposed relation with the moderator means. (Gmelin Inst.)

34144 THERMIONIC POWER CONVERSION TRIODE. Gottlieb, Milton; Zollweg, Robert J. (to Westinghouse Electric Corporation). U. S. Patent 3,254,244. May 31, 1966. Filed June 27, 1961.

A thermionic power conversion device includes a thermionic source of electrons, an electron collector spaced from the source, and an accelerating electrode having a configuration such that it encircles the path between the source and the collector. The accelerating electrode is maintained at a potential more positive than that of the source, and an ionizable gas is disposed between the source and the collector for space charge neutralization. A magnetic field is provided to axially restrict the electrons from the source to reduce the number collected by the accelerating electrode. The electrical output is derived from the collector and the emitter. (B.L.M.)

Elementary Particles and Radiations

See also Field Theory, Scattering Theory, and Symmetries

Refer also to abstract 34109.

34145 (BNL-10215) STRUCTURE IN KN AND $\bar{K}N$ TOTAL CROSS SECTIONS. Giacomelli, G. (Brookhaven National Lab., Upton, N. Y.). May 12, 1966. Contract AT(30-2)-Gen-16. 31p. (CONF-660420-1). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From International Conference on Two-Body Problems at High Energy, Stony Brook, N. Y.

Measurements of the $K^{\pm}$-nucleon total cross sections in the energy range below about 4 Bev/c are discussed. In particular, the results are described of a total cross section experiment of $K^{\pm}$ on hydrogen and deuterium between 1 and 2.4 Bev/c. (M.O.W.)

34146 (CU-1932-256) INELASTIC HIGH-ENERGY NEUTRINO-INDUCED REACTIONS. Rettberg, John W. (Nevis Labs., Columbia Univ., Irvington-on-Hudson, N. Y.). June 1966. Contract AT(30-1)-1932. 97p. (NEVIS-152; R-553; CU-256). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Thesis.

The interaction of high energy neutrinos with an 80-ton aluminum spark chamber were studied. The neutrinos emanate mainly from the two-body decay, in a 75-ft drift space, of pions and kaons which are produced when the external proton beam of the Brookhaven AGS strikes a 12-in. beryllium target. The target was exposed to 1.2×10^{17} 30-Bev/c protons, producing 481 events, in a fiducial volume of 25.4 tons, with a muon candidate of visible momentum ≥1 Bev/c, corresponding to an event rate of about 16 events/10^{14} neutrinos with momentum ≥1 Bev/c/ton Al. A study of neutrino reactions in which pions are produced is presented. Muon angular and visible momentum distributions for neutrino-induced events are presented. The sample of events studied contained roughly equal numbers of

elastic and inelastic events. In approximately 70% of the inelastic events one pion is produced. The assumption that single-pion production proceeds mainly from the excitation and subsequent decay of the nuclear isobar N* ($3/2$, $3/2$) does not account for all the one-pion events observed. A cross section, averaged over our neutrino spectrum, of ~1.5 × 10^{-38} cm^2/neutrino is obtained for all inelastic events. An upper bound of 10% is placed on the amount of neutral current in the interaction hamiltonian which describes the weak interactions. Finally, it is shown that there are no substantial sources of neutrinos, produced in the collision of 30-Bev protons with a target, other than pions and kaons. (auth)

34147 (DESY-66/11) π^+p INTERACTIONS AT 4 Gev/c: SIX-PRONG EVENTS. Bondar, L.; Eickel, K. H.; Kaufmann, H.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). May 1966. 14p. Dep. mn.

Six prong events produced in π^+p interactions at 4 Bev/c were analyzed. The cross sections for the various reactions and for the production of resonances are given. Resonance production is found to be rather strong. The only quasi-two body process clearly identified is $\pi^+p \rightarrow N^{*++}X^0$. Simultaneous production of N^{*++} and ρ^0, N^{*++} and ω, and of η and ρ^0 is also observed. The $\pi^+\pi^-$ mass distribution in reaction $\pi^+p \rightarrow p\pi^+\pi^+\pi^-\pi^-$ shows a peak of about 4 standard deviations above background at 670 Mev with a full width at half-maximum of about 60 Mev. (auth)

34148 (IC-66/43) ALGEBRA OF CURRENTS AND THE MESON FORM FACTORS. Cocho, G.; Ar-Rashid, Harun (International Centre for Theoretical Physics, Trieste (Italy)). May 1966. 8p. Dep. mn.

The equal time commutation relation for the electromagnetic current is used to derive a sum rule for the pion form factor following the covariant method of Fubini. It is shown that the inclusion of pion, ω-meson and A_1-meson (1^+) intermediate states gives a charge radius of the pion in agreement with recent experimental data. (auth)

34149 (IC-66/61) ABSORPTION CORRECTION IN HIGH-ENERGY PHOTOPRODUCTION OF PIONS. Ar-Rashid, Harun; Kawaguchi, M. (International Centre for Theoretical Physics, Trieste (Italy)). June 6, 1966. 8p. Dep. mn.

Photoproduction of charged pions at high energies from protons is evaluated in terms of a one-pion exchange model corrected for final state interactions. The results of this calculation show that such corrections are important even at moderately high energies. (auth)

34150 (IS-T-83) ANTIPROTON-PROTON ANNIHILATION INTO FOUR AND FIVE PIONS, AT 2.7 Bev/c. Lyon, Donald Edward Jr. (Ames Lab., Iowa State Univ. of Science and Tech.). May 1966. Contract W-7405-eng-82. 34p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Thesis.

An investigation of $\bar{p}$-p annihilation into four and five pions at 2.7 Bev/c was carried out at BNL using the Shutt 20-inch liquid hydrogen bubble chamber. The presence of an asymmetry in the angular distribution of the charged pions was confirmed in both channels at this energy. The production of ρ, f, and ω mesons were observed. (M.O.W.)

34151 (ISS-66/15) CALCULATION OF PARTIAL-WAVE ABSORPTIONS AND OF THE MODULI OF THE ELASTIC AMPLITUDES IN NUCLEON-NUCLEON SCATTERING BELOW 1.4 Gev. Amaldi, U. Jr.; Biancastelli, R.; Francaviglia, S. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Apr. 16, 1966. 58p. Dep. mn.

A general procedure is outlined for obtaining the absorptions in each partial wave when the amplitudes for the production of any number of particles in nucleon-nucleon interactions at a given baricentric energy are known. This procedure is then applied to single pion production in nucleon-nucleon interactions at 0.8 to 1.4 Bev. (B.G.D.)

34152 (JINR-P-2711) GAZOVAYA MILTSEN DLYA EKSPERIMENTOV S MEDLENNYMI MEZONAMI. (Gas Target for Slow Meson Experiments). Ermolov, P. F.; Lepilov, V. I.; Mukhin, A. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 5p. Dep. mn.

The gas target is described which is intended to operate with slow mesons at a gas pressure up to 100 atm. Two scintillation counters are placed inside the target. Thereby an effective selection of meson stoppings in gas is attained. The latter is equal to 70% from the total number of stoppings registered by the electronic equipment at a hydrogen pressure of 50 atm. (auth)

34153 (ORO-3065-9) NEW RESULTS CONCERNING DECAY OF THE ETA PARTICLE. Fowler, Earle C. (Duke Univ., Durham, N. C.). May 18, 1966. Contract AT(40-1)-3065. 19p. (CONF-660411-2). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Physical Society Meeting, Washington, D. C.

A review is presented of research work connected with the possible decays of the η resonance. The possibilities that C-violation will appear in these decays are discussed. (M.O.W.)

34154 (UCR-34P107-33) ANNUAL REPORT [ON HIGH-ENERGY PHYSICS]. Kaus, P. E.; Desai, B. R. (California Univ., Riverside). Apr. 1966. Contract AT(11-1)-34. 16p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The relation of conventional field theory to Regge theory is explored and certain criteria on renormalization constants are established. The effect of coupled channels on scattering amplitudes is investigated. An improved version of the ND^{-1} equations is obtained. A new Regge representation is obtained which is superior to all previous representations. It has correct analyticity and unitarity properties, gives correct threshold behavior and converges rapidly. The momentum-transfer dependence of πN charge exchange scattering near forward directions is satisfactorily explained in terms of the ρ Regge-residues. The effect of 2^+ SU(3) nonet exchange at high energies is investigated and it is pointed out that there must be an additional 2^+ SU(3) singlet which would lie on the Pomeranchuk trajectory. The possible existence of an I = 0, D-wave $\pi\pi$ resonance in the vicinity of the ρ-meson and an application of Fadeev equations to the final state $\pi\pi$ interactions in τ and τ' decay are discussed. (auth)

34155 (UCRL-14297) THREE-POLE FIT TO p-p SCATTERING BELOW 350 Mev. Bryan, R. A.; Arndt, R. A. (Lawrence Radiation Lab., Univ. of California, Livermore). June 30, 1965. Contract W-7405-eng-48. 58p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

Despite the complexity of the p-p scattering data, it is shown that it is possible to fit the gross structure of the 0-to 350-Mev scattering amplitude, excluding the S-wave, with a sum of three poles: a vector pole (V), a scalar pole (σ), and the pion pole (π). The vector pole represents a sum of ω, ρ, and ϕ effects. The scalar pole was not established experimentally, but is consistent with the scalar pole at 490 Mev that Thurnauer introduces to fit the low energy $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ data. The real part of the amplitude is fitted with the following parameters: $g_\pi^2 = 12.3$, $g_V^2 = 2.3$, $f_V/g_V = 2.3$, $g_\sigma^2 = 1.6$, and $m_\sigma = 386$ Mev. These values are arrived at by means of an IBM 7094 search against the experimental P, D, F, and G phase shifts of MacGregor, Arndt, Noyes, and Bailey. Studies are also made of four-pole fits to the data, wherein the V pole is resolved into $\rho + \omega$(or ϕ). One effect is to raise the σ mass to 434 Mev. (auth)

34156 (UCRL-14918-T) COMPTON SCATTERING FROM RELATIVISTIC ELECTRONS. Stone, Sam; Nelson, Robert G. (Lawrence Radiation Lab., Univ. of California, Livermore). May 27, 1966. Contract W-7405-eng-48. 62p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

A numerical method is presented for analyzing Compton scattering from a relativistic distribution of electrons. It is comparatively quick and is capable of any desired accuracy. The method is derived within quite a general framework, but for present purposes only a specialized scattering is considered. The special scattering considered is that of a photon from a moving free electron in

lowest order perturbation theory, called single Compton scattering. The electron is taken to be one of a distribution in phase space, and any degeneracy is explicitly neglected by taking the distribution to be relativistic Maxwell-Boltzmann in the non-configuration part of phase space. Finally the distribution (referred to occasionally subsequently as RMB for relativistic Maxwell-Boltzmann) is considered unpolarized. (auth)

34157 (UJV-1576) PERATIZATION OF VERTEXES IN THE THEORY OF WEAK INTERACTIONS WITH W MESONS. Hosek, Jiri (Ustav Jaderneho Vyzkumu, Ceskoslovenska Akademie Ved, Rez). 1966. 16p. Dep. mn.

The integral equation for the vertex with crossed boson lines is solved by the known peratization technique. In the zero energy approach some numerical corrections to the simple vertex are obtained and it is shown that higher order corrections cannot be neglected. The influence of these corrections on the cross section for the neutrino production of the W-meson in the nuclear field and on the W mass is investigated. (auth)

34158 ELECTROPRODUCTION OF NUCLEON RESONANCES. Bjorken, J. D.; Walecka, J. D. (Stanford Univ., Calif.). Ann. Phys. (N. Y.), 38: 35-62(June 15, 1966). (SLAC-PUB-139).

The differential cross section for the process $e + p \rightarrow e + p_R$ where p_R is a nucleon resonance characterized by parity π_R, spin J, and mass M_R is computed. The two inelastic form factors describing this cross section are expressed in terms of three amplitudes characterizing the (p,p_R) electromagnetic vertex. The kinematic and analytic structures of these three amplitudes as a function of q^2 are discussed. The case of the 33 resonance is discussed in some detail. (auth)

34159 QUASI-PARTICLE EXCITATIONS AND THE MANY-BOSON PROBLEM. Etters, Richard D. (Iowa State Univ., Ames). Ann. Phys. (N. Y.), 38: 315-47 (June 27, 1966).

A many-boson theory is developed that is applicable to systems with intermediate as well as weak coupling strength. A transformation of basis from the single-particle representation to that of an independent collection of quasi-particles, which represent the normal modes of the system, is accomplished in an approximate way. The results are in the form of coupled, nonlinear, integral equations for the ground state energy, the exciting energy, the quasi-particle excitation operator, and the momentum distribution function. No a priori assumptions concerning the population in any single low-lying momentum state are required nor is any artificial separation of the single particle zero-momentum state from states of higher momentum necessary. Contact with the results of weak-coupling theories is established by imposing additional restrictions on the interaction potential and on the momentum distribution of particles. It is shown that the weak-coupling equations are valid under more general circumstances than was previously apparent. A general theorem is provided for which the existence of a zero in the excitation spectrum at zero-momentum is required. It is also shown that the low-lying excitations follow a dispersion rule that is linear in momentum, independent of the form of the interaction. The theory is applied to the charged boson gas and, for the case where the zero-momentum state is appreciably depleted, the resulting excitation spectrum is quite different at low momentum from that derived in previous calculations. (auth)

34160 TENTH ANNIVERSARY OF SCIENTIFIC WORK AT THE JOINT INSTITUTE OF NUCLEAR STUDIES. Blokhintsev, D. I. At. Energ. (USSR), 20: 293-310(Apr. 1966). (In Russian).

A review of some research carried out at the Joint Institute for Nuclear Studies in high-energy physics and reactor technology is presented. 83 references. (G.O.Y.)

34161 COVARIANT THEORY OF THE ELASTIC PHOTON-DEUTERON SCATTERING. II. Pokorski, S. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 14: 215-22(1966).

The scalar amplitudes $A_i(s,t,u)$ for γ-d elastic scattering are calculated using the analyticity properties of the A_i's and the unitarity of the S-matrix. Expressions for the amplitudes in the low-energy limit are found. The contributions of the left-hand and right-hand cuts are considered. The procedure for obtaining the dispersion relations and expressions for the cross sections is outlined. (M.J.T.)

34162 CP INVARIANCE, THE PARITINO AND THE SPURION. Kalitzin, N. (Bulgarian Academy of Science, Sofia). Compt. Rend. Acad. Bulg. Sci., 18: 627-9(1965).

A new pseudoscalar particle, called the paritino, of zero mass is hypothesized. The particle is supposed to be stable, electrically neutral, and has a parity of -1. The paritino is assumed to be its own antiparticle. The paritino is very similar to the previously conjectured spurion. The paritino can be used in the theoretical explanation of the parity nonconservation in some weak interactions, for instance the $\tau - \theta$ problem. (C.E.S.)

34163 BARYON CLASSIFICATION AND MASSES. Zaikov, R. Compt. Rend. Acad. Bulg. Sci., 18: 1095-8 (1965).

The mean square masses of the isotopic multiplets, the spin, parity, and dimension of the supermultiplet are listed. Also given are the spin, parity, and the orbital angular momentum and number of mesons produced in the decay of the baryons of the supermultiplets. (J.F.P.)

34164 CLASSIFICATION AND MASSES OF MESONS. Zaikov, R. (Inst. of Physics, Academy of Science, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 19: 17-19(1966).

A list of properties of multiplets of mesons is given. This list includes the mean square mass, charge, spin, parity, and the number of mesons in the multiplet. It is noted that the C and P-parities are equal for all resonance-states, but have opposite signs for the basic mesons. (J.F.P.)

34165 CONTRIBUTION TO THE THEORY OF INDUCED TRANSITIONS IN THE EMISSION FROM A RADIATING ELECTRON. Sokolov, A. A.; Ternov, I. M. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 166: 1332-4(Feb. 21, 1966). (In Russian).

The radiation of an electron moving in a constant and homogeneous magnetic field, induced by an incident external electromagnetic wave, is considered. The damping brought about by the finite time that the electron stays at the initial level is taken into account. Use is made of the electron wave functions calculated earlier (ZhETF v. 25, 698, 1953). The case when the incident electromagnetic wave is linearly polarized is also considered. An expression is derived for the energy absorbed per unit time by an electron during resonant transitions, in terms of the electron field intensity in the incident wave. The formula obtained is applicable for any number of harmonics of all order and has no limitation connected with the velocity of the electron. In the case of a nonrelativistic electron the expression agrees with that obtained by J. Schneider (Phys. Rev. Letters, No. 2, 504, 1959). (ATD)

34166 ELEMENTARY PARTICLE SPECTRA. Smorodinskii, Ya. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Fiz. Szemle, 16: 151-61(May 1966). (In Hungarian).

A brief review of elementary particles is presented with emphasis on the multiplet representations of SU symmetry. (G.O.Y.)

34167 POSSIBLE EXPERIMENTAL OBSERVATION OF THE HELICITY OF THE NEUTRINO. Ryzhanov, S. G. JETP Lett. (USSR)(Engl. Transl.), 3: 299-300(June 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 3: 457-8(June 1, 1966).

It was previously proposed that the helicity of the neutrino could be observed by observing the rotation of a macro-body covered with a β-active material. As an elaboration of this method, it is suggested that radioac-

tive cobalt be coated on either side of the droplet surface by evaporation and rotation observed by use of a new type of gyroscope. (M.H.R.)

34168 POSSIBILITY OF DETERMINING THE RELATIVE SIGNS OF THE AMPLITUDES OF HADRON DECAYS OF HYPERONS. Zakharov, V. I.; Kaidalov, A. B. JETP Lett. (USSR)(Engl. Transl.), 3: 300-2(June 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 3: 459-62(June 1, 1966).

Attention is called to the fact that the relative sign of the amplitudes of Λ_0^0 and Λ_8^0 or Σ_1^+ and Σ_0^+ can be experimentally determined by measuring the transverse polarization of the proton in the decays $\Lambda \rightarrow p\pi^-$ and $\Sigma^+ \rightarrow n\pi^+$. (M.H.R.)

34169 DETERMINATION OF SPIN-PARITY OF RESONANCES. Ramachandran, G. (Matscience, Madras). pp 73-84 of Matscience Symposia on Theoretical Physics. Vol. 1. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966.

The Adair method and the Dalitz method for determining the spin-parity of resonances are briefly described. The results of a study of the Dalitz plots for 3π decays are summarized. (G.O.Y.)

34170 PION RESONANCES. Santhanam, T. S. (Matscience, Madras). pp 85-95 of Matscience Symposia on Theoretical Physics. Vol. 1. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966.

A brief review of each of the pion resonances is presented along with a discussion of the bootstrap mechanism used to explain these resonances. The particle-theory approach to 2π and 3π systems is also considered. (G.O.Y.)

34171 PION-NUCLEON RESONANCES. Venkatesan, K. (Matscience, Madras). pp 97-107 of Matscience Symposia on Theoretical Physics. Vol. 1. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966.

Some mechanisms of the $\pi N \rightarrow \rho N$ interaction, as well as for the production of mesons(π) in π-N collisions through π-π interactions and final state π-N p-wave interaction, are discussed. The inelastic contribution to π-N scattering in the strip approximation is also considered. (G.O.Y.)

34172 INFLUENCE OF PION-NUCLEON RESONANCE ON ELASTIC SCATTERING OF CHARGED PIONS BY DEUTERONS. Devanathan, V. (Univ. of Madras). pp 109-11 of Matscience Symposia on Theoretical Physics. Vol. 1. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966.

The cross section for the elastic scattering of charged pions by deuterons at 300 Mev was calculated. The results of the calculation for various laboratory angles are compared with previous experimental and theoretical results. The importance of these experiments for testing the validity of the impulse approximation is briefly discussed. (G.O.Y.)

34173 PION-HYPERON RESONANCES. Umerjee, R. K. (Matscience, Madras). pp 113-19 of Matscience Symposia on Theoretical Physics. Vol. 1. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966.

A brief study of the family of hyperon isobars characterized by B = 1, S = −1 is presented. (G.O.Y.)

34174 SOME REMARKS ON RECENT EXPERIMENTAL DATA AND TECHNIQUES. Segre, E. (Univ. of California, Berkeley). pp 121-7 of Matscience Symposia on Theoretical Physics. Vol. 1. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966.

Some recent experimental results in elementary-particle physics are summarized. The determination of the quantum numbers of resonances is briefly discussed, and some recent observations of multipion resonances are briefly considered as well as an experiment assigning the spin of the K* resonance. The production of a target containing polarized protons is also discussed. (D.C.W.)

34175 NEW RESONANCES. Maglic, Bogdan (CERN, Geneva). pp 129-40 of Matscience Symposia on Theoretical Physics. Vol. 1. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966.

The properties of the meson(ω), meson(η), meson(κ), and the K* resonance are discussed with emphasis on the spin-parity quantum numbers. The determination of the spin of the meson(ω) is discussed in detail. The use of the sonic spark chamber and the missing-mass spectrometer in the observation of resonances is briefly considered. (D.C.W.)

34176 HIGHER RESONANCES IN THE PION-NUCLEON SYSTEM. Takeda, G. (Tohoku Univ., Sendai). pp 141-57 of Matscience Symposia on Theoretical Physics. Vol. 1. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966.

The physical parameters involved in the higher resonances of the π-N system are discussed and several theoretical models for these resonances are considered. (G.O.Y.)

34177 APPARENT CP VIOLATION IN K_2^0 DECAY DUE TO A NEUTRAL VECTOR BOSON. Srivastava, Prem P. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro); Vidal, Alberto. Notas Fis., Cent. Brasil. Pesqui. Fis., 11: 301-7(1964).

The reported decay of the meson (K_2^0) into two mesons (π) suggesting a violation of CP invariance in weak interactions is considered. It is found that the CP violation can be avoided if an isoscalar neutral vector boson, s, with mass of the order of the mass difference of the mesons (K_2^0) and (K_1^0) and strangeness zero is introduced. This boson is weakly coupled to strangeness currents only, and the interaction conserves the strong selection rules. The process, $K_2^0 \rightarrow \pi + \pi + s$, is calculated. (J.F.P.)

34178 $^1S_0$ p-p SCATTERING PARAMETERS OBTAINED FROM A RE-ANALYSIS OF EXPERIMENTAL DATA. Slobodrian, R. J. (Univ. of California, Berkeley). Nucl. Phys., 85: 33-9(1966). (UCRL-16690).

Existing uncertainties in the scattering parameters that describe the low-energy p-p scattering were significantly reduced extending the analysis up to 4.203 Mev lab energy. A comparison with theoretical predictions is made. (auth)

34179 BASIC NEUTRON-NUCLEON INTERACTION. Perring, J. K. (Atomic Energy Research Establishment, Harwell, Eng.). pp 13-20 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

A status report is presented on scattering experiments at high and low energies and the theoretical interpretation of such interactions. (B.G.D.)

34180 PROTON FORM FACTOR AT HIGH ENERGY. Barnes, K. J. (Imperial Coll. of Science and Tech., London); Guindon, W. G. Nuovo Cimento (10), 44A: 374-8 (July 21, 1966).

It is suggested that high-energy proton-proton scattering could be used to set limits on the high-energy behavior of the proton electromagnetic form factors. Although it is verified that a modified high-energy limit of the Moeller formula is all that is required the complete expression for the elastic electromagnetic interaction of two identical spin-$\frac{1}{2}$ particles with structure was derived in terms of covariant variables and is given for reference. (auth)

34181 DECAYS $\rho^0 \rightarrow \mu^-\mu^+$, $\pi^-\bar{\nu}_\mu$ AND THE PHOTOPRODUCTION OF VECTOR MESONS. Freund, P. G. O. (Univ. of Chicago). Nuovo Cimento (10), 44A: 411-17(July 21, 1966).

On the basis of SU_6 invariance it is shown that the amplitudes f_π and $f_\rho e_\gamma/m_\rho^2$ for the $\pi \rightarrow \mu\bar{\nu}$ and $\rho^0 \rightarrow \mu^+\mu^-$ decays are connected by the relation $(5/3)f_\pi(2G_A(f_\rho e_\gamma/m_\rho^2))^{-1} = m$, where G_A is the axial vector renormalization in $n \rightarrow p$ β-decay $G_A = 1.18$, m is central SU_6 meson mass $m \approx$ (600 to 750) Mev and f_π and $f_\rho e_\gamma$ are given in terms of the $\pi \rightarrow \mu\bar{\nu}$ and $\rho^0 \rightarrow \mu^+\mu^-$ decay rates. A "vector-meson-photon analogy" model is given for the processes of photoproduction of vector mesons at high energies and of high-energy Compton scattering. It is found that $(d\sigma/dt)_{\gamma p \rightarrow \rho p} \approx$

$1/300(d\sigma/dt)_{\pi p \to \pi p}$ and $(d\sigma/dt)_{\gamma p \to \pi p} \approx (1/9 \cdot 10^4)(d\sigma/dt)_{\pi p \to \pi p}$. (auth)

34182 MUON PAIR PRODUCTION IN STRONG INTERACTIONS. Oakes, R. J. (Stanford Univ., Calif.). Contract AF 49(638)-1389. Nuovo Cimento (10), 44A: 440-7 (July 21, 1966).

The general analysis of $\mu^+\mu^-$ (or e^+e^-) pair production from any unpolarized initial state of strongly interacting particles is given to lowest order in the electromagnetic interaction. The process is completely described by five real form factors that are simply related to the density matrix elements for the production of a virtual photon which then decays into the pair. The angular distribution of the $\mu^+\mu^-$ pairs in their center of momentum and their polarizations are computed in terms of the form factors. By measuring the angular distribution and polarizations of the pair one can determine all five form factors and thereby investigate the structure of the production process. Finally, some peripheral-meson-exchange models of the process are considered. (auth)

34183 MULTIPLE MESON PRODUCTION. Takagi, S. (Kyoto Univ.); Dake, S.; Yokoi, K. Nuovo Cimento (10), 44A: 459-68(July 21, 1966).

A statistical model of multiple meson production is proposed, in which the constancy of $\bar{p}_T$, the transverse momenta of generated mesons, is taken into account and which is more consistent and comprehensive than the similar model proposed by the Polish group. In the high-energy limit the following asymptotic behaviors are predicted: i) secondary pions have a uniform logtg θ distribution, ii) multiplicity of secondary pions has a logarithmic dependence on the total available energy of the system. The angular distribution and the multiplicity of secondary pions for finite available energy are also predicted and, on the assumption of $\bar{p}_T = 400$ Mev/c and K = 0.5, the prediction reproduces the experimental results very well in a wide incident-nucleon momentum region: $2 \cdot 10^{10}$ ev/c $\lesssim P_0 \lesssim 2 \cdot 10^{12}$ ev/c. On the above-mentioned basis it is discussed that the essential average feature of ultra-high-energy nucleon-nucleon interaction is condensed in the constancy of $\bar{p}_T$. (auth)

34184 POSITIVE-PION PHOTOPRODUCTION AT 180 DEG NEAR THE SECOND NUCLEON-PION RESONANCE. Schaerf, C. (Stanford Univ., Calif.). Contract Nonr 225(67). Nuovo Cimento (10), 44A: 504-11 (July 21, 1966).

In a previous experiment the cross section for the photoproduction of pions in hydrogen near the second pion-nucleon resonance has been measured at 135° and 180° in the c.m.s. At 180° the measurements did show a very sharp peak at a gamma-ray energy of 700 Mev. The experiment was repeated only at 180°, with improved energy resolution. The new results, in agreement with the old ones, show the same sharp energy dependence at about the same value of the primary energy. (auth)

34185 COMMUTATION PROPERTIES OF THE NONLEPTONIC WEAK HAMILTONIAN AND K DECAYS. Elias, D. K.; Taylor, J. C. (Oxford Univ.). Nuovo Cimento (10), 44A: 518-21(July 21, 1966).

The method of Callan and Treiman applied to nonleptonic decays of kaons is generalized by including $\Delta T = 3/2$ contributions in the hamiltonian. An extrapolation procedure is used for comparing physical decay amplitudes with the amplitudes when one pion has zero mass. The method gives a complete description of the 3-pion decays in terms of the 2-pion ones, which is roughly correct but which depends partly upon unknown π-π phase shifts. (auth)

34186 SEARCH FOR THE INTERMEDIATE BOSON IN WEAK INTERACTIONS. Cowan, C. L. (Catholic Univ. of America, Washington, D. C.); Ueberall, H.; Wang, C. P. Nuovo Cimento (10), 44A: 526-9(July 21, 1966).

A method is suggested by which the high-energy neutrinos in cosmic radiation may be used to detect the intermediate boson hypothesized for weak interactions or to set a much greater lower limit to its mass than current techniques permit. The method is based on the emission of Cherenkov light by neutrino-produced muons in deep ocean water. (L.B.S.)

34187 π^+p INTERACTIONS AT 4 Gev/c: SIX-PRONG EVENTS. Bondar, L. (Technische Hochschule, Aachen); Eickel, H. K.; Kaufmann, H.; (and others). Nuovo Cimento (10), 44A: 530-5(July 21, 1966).

Cross sections are presented for six-prong events observed in interactions of 4 Bev/c mesons (π^+) with protons in the Saclay 81-cm hydrogen bubble chamber. An analysis is made or $N^{*++}(1238)$ production in the $\pi^+p \to p\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-$ reaction and N^{*++}, ω, η, and χ^0 production in the $\pi^+p \to \pi^+\pi^+\pi^+\pi^-\pi^-\pi^0$ reaction. (L.B.S.)

34188 SOME REMARKS ON THE RENORMALIZATION OF THE VECTOR AND AXIAL-VECTOR CABIBBO ANGLES. Furlan, G. (Univ., Trieste); Renner, B. Nuovo Cimento (10), 44A: 536-41(July 21, 1966).

The determination of vector and axial vector Cabbibo angles is examined within the framework of SU_3 symmetry, taking into account the deviation of the form factor and coupling constants from $F^+_{k\pi}(0) = 1$ and $f_k = f_\pi$ owing to SU_3-symmetry-breaking interactions. Matrix elements of the weak currents are introduced for the $k^+ \to \mu^+\nu_\mu$, $\pi^+ \to \mu^+\nu_\mu$, $K^+ \to \pi^0 e^+\nu e$, and $\pi^+ \to \pi^0 e^+\nu_e$ decays. Relations between $F^+_{k\pi}$, $F^-_{k\pi}$, and f_k/f_π are obtained from current algebra and the assumption of vector-meson dominance which reproduce the results of SU_3 symmetry. (L.B.S.)

34189 ALGEBRA OF CURRENTS AND THE FORM FACTORS OF K_{l3} DECAY. Riazuddin (Univ. of Pennsylvania, Philadelphia); Fayyazuddin. Nuovo Cimento (10), 44A: 546-52(July 21, 1966).

A method is given for determining the form factors $F_+(t)$ and $F_-(t)$ and the parameter $\xi(t) = F_-(t)/F_+(t)$ for the K_{l3} decay within the framework of the algebra of currents. Expressions are derived for $F_+(t)$ and $\xi(t)$, which include the terms $0(\lambda)$ and $0(\lambda^2)$ denoting the first- and second-order SU_3-symmetry breaking. The experimental implications of the relations are discussed using the resonance model for the form factors. (L.B.S.)

34190 CURRENT COMMUTATION RELATIONS AND $J = 1/2^-$ BARYON RESONANCES. Bietti, A. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 44A: 553-7(July 21, 1966).

Static sum rules for the electric dipole moment of the electromagnetic currents were previously derived, using equal-time commutation relations, and predictions were made on the N** photoproduction on proton, under the assumption that the sum rules are dominated by the isovector transition moments between the proton and the $J = 3/2^-$ $I = 1/2$ N**(1518) pion-nucleon resonance. The possible presence of $I = 1/2$ and $I = 3/2$, $J = 1/2^-$ resonances for the electric-dipole sum rule is investigated. It was found that the sum rules can be saturated without the presence of $J = 1/2^-$ resonances; that the transition amplitudes between the proton and these resonances are small compared to the p-N** amplitude. The results are consistent with the hypothesis of considering only nonresonant S-wave single-pion production amplitudes. (L.B.S.)

34191 $J^P = 2^+$ MESONS. Ram, B. (Univ. of North Carolina, Chapel Hill). Nuovo Cimento (10), 44A: 558-9 (July 21, 1966).

The recently established nonet of $J^P = 2^+$ mesons is discussed to show evidence in support of the oscillator model. A mass relation is obtained for the tensor mesons, which is in qualitative agreement with experiment. (L.B.S.)

34192 THE ρ + R MODEL AND pn CHARGE-EXCHANGE SCATTERING. Hoegaasen, H.; Frisk, A. (CERN, Geneva). Phys. Lett., 22: 90-1(July 15, 1966).

From medium energy nucleon-nucleon data it is concluded that a consistent description in terms of Regge poles is possible only if the polarization is nonzero in $\pi^-p \to \pi^0 n$ or $\pi^-p \to \eta n$ at medium energies. (auth)

34193 CALCULATION OF QUARK PRODUCTION. Chilton, F.; Horn, D.; Jabbur, R. J. (Argonne National Lab., Ill.). Phys. Lett., 22: 91-3(July 15, 1966).

Cross sections for the production of quark-antiquark pairs in π-N and N-N collisions are calculated using an absorptive peripheral model. The results are found to be of the order of magnitude of a few microbarn and rather smoothly dependent on the mass of the quark. (auth)

34194 COMPARISON OF $K_{\pi 3}$ EXPERIMENTS WITH PREDICTIONS FROM EQUAL-TIME COMMUTATORS. Nefkens, B. M. K. (Univ. of Illinois, Urbana). Phys. Lett., 22: 94-6(July 15, 1966).

The predictions by Callan-Treiman concerning $K_{\pi 3}$ decays, which are based on equal-time commutation relations, are compared with existing experimental data extrapolated to $E(\pi) = 0$. The agreement is good. (auth)

34195 Ω^- DECAY MODES. Rajaraman, R. (Univ. of Southern California, Los Angeles). Phys. Lett., 22: 102-4 (July 15, 1966).

An attempt is made to relate certain decay modes of the Ω^- particle, by using the now well-known algebra of current components and the PCAC hypothesis. For the two pionic modes $\Omega^- \to \Xi^- + \pi^0$ and $\Omega^- \to \Xi^0 + \pi^-$ the $\Delta I = 1/2$ rule is obtained, and the differences between these cases and the theories of $1/2^+$ hyperon decays are pointed out. Although the experimental data concerning the Ω^- are extremely slender, there is at least one event for each of the above modes, and the observed lifetimes are in fine agreement with the prediction. Using a similar procedure, the mode $\Omega^- \to \Xi^0 + \pi^0 + e^- + \bar{\nu}$ is also related to $\Omega^- \to \Xi^0 + e^- + \bar{\nu}$. These modes, although not observed so far, are allowed energetically with sufficient phase space left for the products. (auth)

34196 TEST OF CP AND C INVARIANCES IN $\bar{p}p$ ANNIHILATIONS AT 1.2 Gev/c INVOLVING STRANGE PARTICLES. Dobrzynski, L. (College de France, Paris); Xuong, Nguyen-Huu; Montanet, L.; Tomas, M.; Duboc, J.; Donald, R. A. Phys. Lett., 22: 105-8(July 15, 1966).

No indication of violation of either CP or C invariances was found. Using a simple model, an estimate of $(0.4 \pm 1.0) \times 10^{-2}$ was made for the relative amplitude of CP violation and of $(0.4 \pm 1.0) \times 10^{-2}$ for C violation. The data are also consistent with a relative amplitude of P violation of $(0.1 \pm 1.0) \times 10^{-2}$. (auth)

34197 THE PRODUCTION OF STRANGE PARTICLES IN 8-Gev π^+-PROTON INTERACTIONS. I. ΛK PRODUCTION IN THREE- AND FOUR-BODY FINAL STATES. Brandt, S. (CERN, Geneva); Cocconi, V. T.; Czyzewski, O.; (and others). Phys. Lett., 22: 109-11(July 15, 1966).

Results are presented on ΛK associated production in 3 and 4-body reactions of 8 Bev/c π^+ in hydrogen. Cross sections are presented and evidence is shown for the reaction $\pi^+p \to Y^*(1385)\, K^*(890)$. (auth)

34198 EVIDENCE AGAINST THE INTERPRETATION OF THE A_1 ENHANCEMENT AS A KINEMATIC EFFECT. Deutschmann, M. (Technische Hochschule, Aachen); Steinberg, R.; Weber, H. Phys. Lett., 22: 112-15(July 15, 1966).

The mechanisms proposed to explain the $\pi\rho$ enhancement at 1.1 Bev (A_1 meson) as a kinematic effect are discussed and results are presented, derived from a study of 8 Bev/c π^+p interactions, which are inconsistent with the interpretation of the A_1 as a kinematic effect and hence favor its interpretation as a resonant state. (auth)

34199 $\bar{K}N$ EFFECTIVE RANGE APPROXIMATION. Kittel, W.; Otter, G. (Institut fuer Hochenergiephysik, Vienna). Phys. Lett., 22: 115-17(July 15, 1966).

A determination for the effective range parameters was carried out for S wave $\bar{K}N$ interactions up to 1520 Mev c.m. energy combined with the data of the $Y_0^*(1405)$ resonance. For the best solution the results are: $A_0^0 = (-1.54 + i\ 0.53)$ fm; $R_0^0 = 0.11$ fm; $A_1^0 = (-0.22 + i\ 0.44)$ fm; $\epsilon = 0.31$ rad; $\alpha = -1.79$ rad. (auth)

34200 EVIDENCE FOR A DIPION ENHANCEMENT NEAR 400 Mev. Kopelman, J. B. (Univ. of Colorado, Boulder); Allen, D. D.; Godden, G.; Marshall, L.; Urvater, E.; Juhala, R. E.; Rhode, J. L. Phys. Lett., 22: 118-20 (July 15, 1966).

In 5.0 Bev/c K^- meson interactions 5500 four-prong events were analyzed. Six hundred and fifty events of the type $K^-p \to K^-p\pi^+\pi^-$, corresponding to a 1 mb production cross section, show a dipion mass enhancement at 410 ± 20 Mev and a width of 70 ± 25 Mev. This enhancement cannot be explained in terms of nonresonant background effects of the type recently considered in the literature. (auth)

34201 PRODUCTION PROPERTIES AND DECAY MODES OF THE ϕ MESON. Lindsey, James S.; Smith, Gerald A. (Univ. of California, Berkeley). Phys. Rev., 147: 913-22(July 29, 1966).

The reaction $K^-p \to \Lambda\phi$ was studied in an exposure of the LRL 72-in. bubble chamber to a separated beam of 2.1- to 2.7-Bev/c mesons (K^-). The decay branching ratios for K^+K^-, $K_1^0K_2^0$, $\rho\pi$, $\eta\gamma$, $\rho\gamma$, and $\omega\gamma$ were measured, and the ratio $\beta = [\Gamma(\phi \to K_1^0K_2^0)/\Gamma(\phi \to K^+K^-)]$ was used as a test of the ϕ's spin. The quantum numbers assigned to the ϕ, $J^{PC} = 1^{--}$ and I = 0, were confirmed. Production processes were investigated using the correlation-matrix method of Berman and Oakes. The low-momentum 2.1-Bev/c beam momentum) data fit a model of K and K* exchange, but the high-momentum (2.45 to 2.7 Bev/c) data are inconsistent with the model. Also, other final states involving $K\bar{K}$ pairs were investigated, and their cross sections were measured. But, except for the production of the reaction $K^-p \to Y_1^*(1385)\phi$, no previously unreported effects were observed. (auth)

34202 SEARCH FOR DIBARYON RESONANT STATES. Bierman, E.; Colleraine, A. P.; Nauenberg, U. (Princeton Univ., N. J.). Phys. Rev., 147: 922-31(July 29, 1966). (PPAD–580–E).

A search for dibaryon resonant states was carried out in p-p collisions at 5.0 Bev/c. A total of ~1400 events was measured and analyzed. No effect was detected which could be construed as being due to a dibaryon resonance. The Y_1^* and the N^{*++} resonances were observed. The effect of the 1688^{*++} resonance in its Λ^0K^+ decay mode was also observed. The data are consistent with the one-pion-exchange model. (auth)

34203 π^- + p INTERACTIONS AT 646 Mev. Oliver, John D.; Nadelhaft, I. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 147: 932-8(July 29, 1966).

A 14-in. liquid-hydrogen-filled bubble chamber in a 17.5-kG magnetic field was exposed to a beam of negative pions. About 26,000 pictures were taken and examined for the following final states: (1) elastic scattering (π^-p); (2) π^+ production ($\pi^-\pi^+n$); (3) π^0 production ($\pi^-\pi^0p$); (4) neutrals. Values for the cross sections for these processes were obtained. The elastic-scattering angular dependence in the cms was fitted by a power-series expansion in $\cos\theta$ and the coefficients were evaluated. Cross sections for multiple-pion production were also measured as well as the total neutral cross section, the total charged-events cross section, and the total cross section. For single-pion production events, two-body mass distributions and angular distributions were compared with the predictions of the Olsson-Yodh isobar model. (auth)

34204 A MEASUREMENT OF THE K_1^0 LIFETIME. Kirsch, L.; Schmidt, P. (Columbia Univ., New York). Phys. Rev., 147: 939-41(July 29, 1966). (CU–1932–252; NEVIS–146; R–539; CU–252).

On the basis of about 5000 meson (K^0) decays into two charged pions in a hydrogen bubble chamber, the lifetime of the meson (K_1^0) was measured to be $0.843 \pm 0.013 \times 10^{-10}$ sec. (auth)

34205 $2\pi^0$ MASS SPECTRUM AND DETERMINATION OF THE SPIN OF THE f^0 USING $\pi^- + p \to \pi^0 + \pi^0 + n$ at 10 Bev/c. Wahlig, M.; Shibata, E.; Gordon, D.; Frisch, D. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 147: 941-5(July 29, 1966). (MIT-2098-204).

The properties of the π^0-π^0 system were studied using the interaction $\pi^- + p \to \pi^0 + \pi^0 + n$ at 10 Bev/c, by observing

only the four gammas produced. The $\pi^0\pi^0$ mass spectrum shows a strong f^0 peak centered at 1275 ± 25 Mev. A broad second enhancement, extending from threshold to ~800 Mev, can not be interpreted definitely because of a large background (only in this mass region) of gammas from $3\pi^0$ events events. The f^0 differential production cross section falls off initially as e^{At}, where A ≈ 10. For small four-momentum transfer events ($t \leq 5m_\pi^2$), the $\pi\pi$ scattering distribution in the f^0 rest frame agrees well with $[P_2(\cos\theta_{\pi\pi})]^2$, where P_2 is the second Legendre polynomial. This indicates that the simplest one-pion-exchange model is applicable under these conditions, and allows one to conclude that the f^0 spin is 2, not 0 or 4. The f^0 production cross section times its branching ratio for $2\pi^0$ decay is 20 ± 5 μb. The g^0 meson (2π resonance at 1670 Mev) is not observed, and an upper limit of 5 μb is set for its production cross section times its branching ratio into $2\pi^0$'s. (auth)

34206 SOME PROPERTIES OF Ξ^- AND Ξ^0 HYPERONS PRODUCED IN K^-p INTERACTIONS BETWEEN 1.05 AND 1.7 Bev/c. Berge, J. Peter; Eberhard, Philippe; Hubbard, J. Richard; Merrill, Deane W.; Button-Shafer, J.; Solmitz, T.; Stevenson, M. Lynn (Univ. of California, Berkeley). Phys. Rev., 147: 945-61(July 29, 1966).

The production of cascade hyperons by incident K^- on hydrogen was studied from 1.05 to 1.70 Bev/c. Production cross sections rise over this momentum range, reaching about 150 μb for Ξ^-K^+ production and about 100 μb each for Ξ^0K^0 and $\Xi\pi K$. Production of the $\Xi^*(1530)$ near threshold is observed, and the assignment $I = 1/2$ for this resonance is confirmed. The Ξ decay analysis yields weak evidence for $J_\Xi = 1/2$. For $J_\Xi = 1/2$, the decay-parameter results are $\alpha_{\Xi^-} = -0.368 \pm 0.057$ and $\Phi_{\Xi^-} = \tan^{-1}(\beta/\gamma)_\Xi = 0.008 \pm 0.186$ rad. The final-state $\pi\Lambda$ phase difference is then $(\delta_P - \delta_S) = \tan^{-1}(\beta/\alpha)_\Xi = 179 \pm 26$ deg. No significant violation of the $\Delta I = 1/2$ rule was observed. The upper limit on the leptonic decay rate, $(\Xi^- \to \Lambda e^-\bar{\nu})/(\Xi^- \to \Lambda\pi^-)$, was found to be 0.5%. (auth)

34207 MAGNETIC MOMENTS OF THE STRANGE BARYONS AND THE ALGEBRA OF CURRENTS. Mathur, V. S.; Pandit, L. K. (Univ. of Rochester, N. Y.). Phys. Rev., 147: 965-72(July 29, 1966). (UR-875-127).

Using equal-time commutation relations of the axial-vector charges with the isoscalar and isovector electromagnetic current densities, the magnetic moments of the strange members of the baryon octet and the Σ^0-Λ transition moment are calculated in terms of the pseudoscalar-meson photoproduction amplitudes, which are evaluated using low-lying baryon resonant states. The results agree very well with the experimental values available for the Σ^+ and the Λ magnetic moments. A comparison is also made with the results of the SU(3) symmetry. (auth)

34208 HIGHER SYMMETRIES AND THE 2^+ MESONS. Horn, D. (Argonne National Lab., Ill.); Coyne, J. J.; Meshkov, S.; Carter, J. C. Contract NA-onr-7-66. Phys. Rev., 147: 980-4(July 29, 1966).

The two-body decay widths of the nine $J^P = 2^+$ mesons are calculated in the framework of relativistic SU(6). It is shown that it can not distinguish from the decays whether the mesons should be accommodated in a 189 or 405 representation. An analysis of the masses of these mesons indicates that the 189 may be definitely ruled out. A mass formula pertinent to the 405 is derived which is fairly well satisfied and which indicates no inconsistency with placing the 2^+ mesons in this representation. Conclusions about the quark-quark and quark-antiquark interactions are drawn from this assignment. (auth)

34209 BOUND STATES AND BOOTSTRAPS IN FIELD THEORY. Broido, Michael M. (Courant Inst. of Mathematical Sciences, New York. Princeton Univ., N. J.); Taylor, John G. Phys. Rev., 147: 993-1016(July 29, 1966).

A general, model-independent theory of composite particles is presented. Starting from a general local Lagrangian containing an elementary particle, it is shown how this particle becomes composite (in a precisely defined sense) as its wave-function renormalization constant tends to zero. As this limit is taken, the usual dynamical type of field equation changes its form. It is shown that the Green's functions of the theory still possess the usual physical interpretation in the limit; in particular, for renormalizable theories, if a certain coupling constant does not tend to zero, the composite propagator possesses a pole at the composite mass and with nonzero residue. The operator form of the Green's-function equations describing the composite particle can be manipulated by natural approximations to explain a wide variety of known model-dependent results on composite particles, and in particular to obtain all the usual types of bootstrap equations. A preliminary classification of the operator equations is presented, which shows that many of them can not possess physically meaningful solutions. The results agree qualitatively with earlier, heuristic discussions. Finally some remarks about the possibility of "bootstrapped symmetry schemes" are made. (auth)

34210 ELECTROMAGNETIC MASS SPLITTINGS OF THE N AND N*(1238 Mev). Shaw, Gordon L. (Univ. of California, Irvine); Wong, David Y. Phys. Rev., 147: 1028-32(July 29, 1966).

The Dashen-Frautschi calculation of the neutron-proton mass difference is examined with emphasis on the nature of the D function. It is concluded that the calculation of the mass difference depends critically on the details of the strong interactions. On the other hand, the ratio of the mass difference of the charged N* resonances to the neutron-proton mass difference is insensitive to these details. (D.C.W.)

34211 NEUTRAL LEPTON CURRENTS. Wu, Tai Tsun (Harvard Univ., Cambridge, Mass.). Phys. Rev., 147: 1033-4(July 29, 1966).

The possibility of a self-coupled neutral letpon current is considered. (G.O.Y.)

34212 ASSOCIATION BETWEEN THE DIP IN THE $\pi^-p \to \pi^0n$ HIGH-ENERGY ANGULAR DISTRIBUTION AND THE ZERO OF THE ρ TRAJECTORY. Arbab, Farzam; Chiu, Charles B. (Univ. of California, Berkeley). Phys. Rev., 147: 1045-7(July 29, 1966). (UCRL-16686).

The angular distributions of $\pi^-p \to \pi^0n$ near the forward direction from 3 to 18 Bev/c, measured by the Saclay-Orsay group, displayed a dip near $t = -0.6$ (Bev/c)^2 independent of energy. To analyze the data it was assumed that the amplitude is dominated by the ρ-trajectory exchange, and the amplitude was parametrized with six parameters (two for the ρ trajectory, two for the non-spin-flip residue, and two for the spin-flip residue). The data above 5 Bev/c with $|t| \leq 1.4$ were included in this analysis. A solution with $\chi^2 = 98$ was found for a total of 62 points. The result for the ρ trajectory is $\alpha_\rho = 0.56(\pm0.01) + 1.08(\pm0.03)\,t$. The result shows that the observed dip can be explained by the necessary vanishing of the spin-flip amplitude when the exchange angular momentum passes through 0. (auth)

34213 DYNAMICS AND SYMMETRIES OF NONLEPTONIC HYPERON DECAYS; SCALAR MESON COUPLINGS. Loebbaka, David; Pati, Jogesh C. (Univ. of Maryland, College Park). Phys. Rev., 147: 1047-57(July 29, 1966).

The dynamics and symmetries of nonleptonic hyperon decays are investigated using a model that involves six unknowns. A number of decay-mode predictions of the model are then derived. (G.O.Y.)

34214 ALGEBRA OF CURRENT COMPONENTS AND DECAY WIDTHS OF ρ AND K* MESONS. Riazuddin (Univ. of Pennsylvania, Philadelphia); Fayyazuddin. Phys. Rev., 147: 1071-3(July 28, 1966).

The decay widths of the ρ and K* mesons are calculated using the equal-time commutation relations of the chiral SU(3) ⊗ SU(3) current algebra and the concept of partially conserved axial-vector current. The results are compared with experimental observations. (D.C.W.)

34215 SENSITIVITY OF BALAZS-TYPE BOOTSTRAPS TO THE MATCHING POINT. Williamson, Marlene R.; Everett, Allen E. (Tufts Univ., Medford, Mass.). Phys. Rev., 147: 1074-6(July 29, 1966).

The sensitivity of the self-consistent values for the position and width of the meson (ρ), as given by the two-pole method of Balázs, to the value of the matching parameter ν_F, is studied. It is found that, while self-consistent solutions exist for all values of ν_F studied, the resonance parameters ν_F and Γ may vary by roughly factors of 2 and 1.4, respectively, as ν_F is varied over a reasonable range. By requiring that the second derivatives of the two forms of the amplitude match or, equivalently, by requiring that there be reasonable agreement between the two forms of the amplitude and of the first derivative over a range of values of ν_F, and not just at the matching point, a plausible argument can be given for which value of ν_F should be selected. The resonance position corresponding to this value of ν_F is in somewhat better agreement with experiment than that obtained with the value of ν_F used in Balázs's original paper, while the width obtained is slightly wider and hence in worse agreement. (auth)

34216 NONRELATIVISTIC MOTION OF PARTICLES IN STRONGLY BOUND S STATES. **Greenberg, O. W.** (Univ. of Maryland, College Park. Rockefeller Univ., New York). **Phys. Rev., 147: 1077-80 (July 29, 1966).**

The possibility that particles in the ground state can be strongly bound and still move nonrelativistically is studied for a variety of potentials. It is shown that this is not possible for a Yukawa potential, a purely attractive superposition of Yukawa potentials, or a Coulomb potential. Nonrelativistic motion is possible in an exponential potential. (D.C.W.)

34217 MESON MASSES AND DECAYS. **Yellin, Joel** (Univ. of Chicago). **Phys. Rev., 147: 1080-93 (July 29, 1966). (COO-264-278; EFINS-65-79).**

The masses, decay rates, and decay spectra of the octet of 0^- mesons, the nonet of 1^- mesons, the X(960) resonance, and a proposed $\eta^*(1620)$ resonance having the quantum numbers of $\eta(550)$ are considered. Spin-unitary-spin symmetry and nonet symmetry are used so that the mesons fall into 36 states, combining an SU(6)1, with an SU(6)35. Further, the strength of the couplings of the SU(3) octets in the 36 with respect to the SU(3) singlets is fixed by assuming that the form of the coupling remains unchanged when the singlet states are included. After making a particular choice of Hamiltonian the masses and the decay rates are predicted, using as input the masses of the octet of 0^- mesons and (M_ϕ, M_ω). These predictions are in reasonable agreement with presently existing experimental data. Related meson decays using the above scheme to eliminate the arbitrariness in the relative coupling strength of the singlet states are also discussed. The model of Gell-Mann, Sharp, and Wagner was used and invariant-mass spectra for the three-body decays are given. (auth)

34218 BARYON ELECTROMAGNETIC MASS DIFFERENCES AND OCTET ENHANCEMENT IN BROKEN SU(3) SYMMETRY. **Gilman, Frederick J.** (California Inst. of Tech., Pasadena). **Contract AT(11-1)-68. Phys. Rev., 147: 1094-1110 (July 29, 1966).**

The contribution of self-consistent terms arising from strong-interaction reciprocal bootstraps to the electromagnetic mass differences of the Σ, Y_1^*, Ξ, and Ξ^* is considered within the formalism developed by Dashen and Frautschi. It is shown that the self-consistent terms from a Σ-Y_1^* reciprocal bootstrap lead to an enhancement of the Σ and Y_1^* electromagnetic mass differences transforming as I_z, but not of those transforming as I_z^2. The Ξ and Ξ^* electromagnetic mass differences are found not to be enhanced by a Ξ-Ξ^* reciprocal bootstrap mechanism, but the large Ξ^0-Ξ^- mass difference is found to be explained by terms arising from external Σ mass shifts in the $\bar{K}\Sigma$ channel of a Ξ bootstrap calculation. (auth)

34219 STUDY OF POSSIBLE PRACTICAL RELATIVISTIC GENERALIZATIONS OF THE FADDEEV EQUATIONS IN AN ACTUAL MODEL. **Ahmadzadeh, A.; Tjon, J. A.** (Univ. of California, San Diego, La Jolla). **Phys. Rev., 147: 1111-15 (July 29, 1966).**

The relativistic Faddeev equations derived from the Bethe-Salpeter equation are considered with the alternative rules of Blankenbecler and Sugar which put the intermediate particles on the mass shell. The above rules give rise to three alternative sets of equations. Another set of equations is obtained by introducing relativistic kinematics and phase-space factors in the (nonrelativistic) Faddeev equations. Each alternative set of equations is applied to the problem of the possible existence of the pion as a bound state of three pions, considered previously. Although qualitative results are similar, quantitative results from the various alternatives differ considerably. Because of the phase-space factors, no cutoff is needed in these calculations. It is also found that the three pions can form a bound state at the pion mass only if the scattering length in the two-body amplitude is negative. (auth)

34220 NONET MESON COUPLINGS TO BARYONS. **Barger, V.; Olsson, M.; Sarma, K. V. L.** (Univ. of Wisconsin, Madison). **Contract AT(11-1)-30. Phys. Rev., 147: 1115-17 (July 29, 1966). (COO-30-106).**

A nonet coupling ansatz which requires zero couplings for the nonstrange baryons to the $\phi(1^{--}$, 1020-Mev) and $s(2^{++}$, 1525-Mev) I = 0 mesons is investigated in the framework of a Regge-pole model for forward elastic scattering amplitudes at high energy. The analysis indicates that total cross sections are roughly consistent with the ansatz. (auth)

34221 η-N INTERACTION AND η PRODUCTION IN π-N(γ-N) COLLISIONS. **Minami, Shigeo** (Osaka City Univ.). **Phys. Rev., 147: 1123-9 (July 29, 1966).**

Experimental data for the $\pi^- + p \rightarrow \eta + n$ reaction near threshold are analyzed by using the Breit-Wigner resonance formulas for S_{1_2} and D_{3_2} states. It is shown that the effects of D_{3_2} are comparable to or larger than those of S_{1_2} in the neighborhood of the observed peak of $\sigma(\pi^- + p \rightarrow \eta + n)$, and that from only the data for $\sigma(\pi^- + p \rightarrow \eta + n)$, the mass ($\omega_r$) of the S_{1_2} resonant state can not be determined unambiguously without knowledge of its partial widths. In order to get some information concerning the partial widths Γ_η and Γ_π of the S_{1_2} resonant state into the channels $\eta + N$ and $\pi + N$, the $\gamma + p \rightarrow \eta + p$ and $\gamma + N \rightarrow \pi + N$ reactions are studied. As one of the methods to determine value of the ω_r, measurements of energy spectrum of Σ^- in a reaction $K^- + d \rightarrow \Sigma^- + p + \eta$ are suggested. (auth)

34222 INFRARED APPROACH TO LARGE-ANGLE SCATTERING AT VERY HIGH ENERGIES. **Kastrup, H. A.** (Princeton Univ., N. J.). **Phys. Rev., 147: 1130-5 (July 29, 1966).**

The hypothesis is investigated that the observed exponential decrease of the elastic large-angle high-energy proton-proton cross section is a consequence of soft-meson emission in strong interactions at very high energies. This interpretation is suggested by the observation of leading particles and low cms energies of the secondary mesons in cosmic-ray collisions. Neglecting the recoil of the soft mesons implies the factorization of the cross section into a potential part and an infrared part which is given by Poisson's distribution law. These properties alone provide a number of interesting experimental predictions. Adding the assumption of asymptotic dilatation invariance determines the energy dependence of the potential cross section and yields new results: The magnetic form factor of the nucleon becomes a simple function of the multiplicity of soft mesons produced in quasi-elastic electron-nucleon scattering. If this relation can be confirmed experimentally, it will provide a new method of measuring electromagnetic form factors at very high energies. Furthermore, the factor $\exp(-\bar{n})$ of the Poisson distribution can account for the exponential decrease of the elastic proton-proton cross section, and this interpretation gives several new experimental predictions. (auth)

34223 MESON MASS SPLITTING, COPLANAR U(3) x U(3) SYMMETRY, AND NUCLEON-NUCLEON SCATTERING. **Lai, C. S.** (Univ. of Chicago). **Phys. Rev., 147: 1136-8 (July 29, 1966).**

For the case of nucleon-nucleon scattering, it is shown that there are large corrections to the prediction of co-

planar U(3) × U(3) symmetry as a consequence of the mass-splitting effects in the intermediate meson states of the crossed channels. These corrections are calculated for certain coefficients of the pp scattering amplitude by using a meson pole model. A comparison is given with the result of experimental phase-shift analyses. (auth)

34224 HIGH-ENERGY πp SCATTERING AND THE π-π J = 0, T = 0 ANTIBOUND STATES. Islam, M. M. (Brown Univ., Providence). Phys. Rev., 147: 1144-7 (July 29, 1966). (NYO-2262-104).

A model for high-energy πp scattering is presented. Partial waves with $l \leq l_a$ are taken to be completely imaginary and those with $l_c \geq l > l_a$ are given by their Born terms. Values of the partial-wave inelasticity $\eta_{l\pm}^{I}$ are calculated dynamically. A force similar to the exchange of a scalar particle of mass $<2\mu$ but with residue of opposite sign is found. This force gives a repulsive real part of the forward scattering amplitude. The origin of this force is explained as due to the exchange of the π-π J = 0, T = 0 antibound state or ABC particle. (auth)

34225 EXCHANGE CONTRIBUTION OF THE π-π J = 0, T = 0 ANTIBOUND STATE. Islam, M. M. (Brown Univ., Providence). Phys. Rev., 147: 1148-52 (July 29, 1966). (NYO-2262-102).

It is shown that the exchange of the π-π J = 0, T = 0 antibound state in the crossed channel for π-π and π-N scattering gives a contribution similar to that due to the exchange of a scalar particle but with opposite sign of the residue. In the direct channel, this antibound state gives a large T = 0 s-wave π-π scattering length, as suggested by Atkinson to explain the ABC phenomenon. The contribution of the antibound state to the physical amplitude is evaluated using dispersion relations involving the physical sheet and the second Riemann sheet. (auth)

34226 ANALYSIS OF η^0, $X^0 \rightarrow \pi^+\pi^-$ WITH A POSSIBLE C VIOLATION. Barrett, Barbara (San Francisco State Coll.); Truong, Tran N. Phys. Rev., 147: 1161-5 (July 29, 1966). (NYO-2262-109).

The asymmetry of the π^+,π^- energy spectra in η^0, $X^0 \rightarrow \pi^+\pi^-\gamma$ decays is analyzed under the assumption of a possible C violation in electromagnetic interactions. It is assumed that the P- and D-wave π-π phase shifts satisfy an effective-range expansion whose parameters are determined by the position and width of the ρ^0 and f^0 resonances. Within the validity of this assumption, the upper limit for the asymmetry parameter in η^0 decay is found to be 1.1%, the upper limit for the asymmetry parameter in X^0 decay is 18%. For any given values of the decay radius and the ratio of the C-violating to C-conserving coupling constants, the $\pi^+\pi^-$ asymmetry is much larger in X^0 decay than in η^0 decay; hence the notion of maximal C violation in electromagnetic processes can be suitably tested in this decay. This is, moreover, a more sensitive test than a search for the neutral mode $X^0 \rightarrow \pi^0\pi^0\gamma$, since the $\pi^+\pi^-$ asymmetry can be as large as 10% for low values of $R_X = 0.04$. (auth)

34227 ONE-DIMENSIONALITY OF RELATIVISTIC PARTICLE FORCES FOR UNIFORM CENTER-OF-MASS MOTION. Currie, D. G. (Northeastern Univ., Boston); Jordan, T. F. Phys. Rev. Lett., 16: 1210-11(June 27, 1966).

It is shown that the acceleration of the center-of-mass coordinate of relativistic particle forces must be zero if the Lorentz-invariant equations of motion are also Galilean invariant. (G.O.Y.)

34228 NEUTRON-PROTON ELASTIC SCATTERING FROM 1 TO 6 Gev. Kreisler, M. N. (Stanford Univ., Calif.); Martin, F.; Perl, M. L.; Longo, M. J.; Powell III, S. T. Phys. Rev. Lett., 16: 1217-20(June 27, 1966).

Neutron-proton elastic scattering was investigated at 1.0 to 6.3 Bev from the small-angle diffraction peak region to the region beyond 90° in the cms. A strong diffraction peak, which has a roughly exponential behavior, was observed at all energies. The differential n-p cross section was found to be roughly isotropic near 90°, and its minimum was determined to be at or just beyond 90°. No clear evidence for a second forward peak in the n-p system was found. (G.O.Y.)

34229 TOTAL AND DIFFERENTIAL CROSS SECTIONS FOR $\pi^- + p \rightarrow \eta + n$ FROM THRESHOLD TO 1300 Mev. Richards, W. Bruce (Univ. of California, Berkeley); Chiu, Charles B.; Eandi, Richard D.; (and others). Phys. Rev. Lett., 16: 1221-3(June 27, 1966). (UCRL-16195(Rev.))

The total and differential cross sections for the interaction $\pi^- + p \rightarrow \eta + n$ with $\eta \rightarrow 2\gamma$ were measured for seven meson (π^-) energies from threshold to 1300 Mev. It was found that the total cross section rises steeply from threshold to a value of nearly 1 mb at an incident meson (π^-) energy between 655 and 704 Mev, and these falls gradually to 0.25 mb at 1300 Mev. This result agrees with previous observations. The η angular distributions obtained are isotropic near threshold; but, in contrast to previous experiments, require terms through $\cos^2\theta_\eta$ for an adequate fit at 655 Mev. Higher-order terms appear with increasing energy. (G.O.Y.)

34230 EXPERIMENTAL EVIDENCE CONCERNING CHARGE-CONJUGATION NONINVARIANCE IN THE DECAY OF THE η MESON. Baltay, Charles (Columbia Univ., New York); Franzini, Paolo; Kim, Jewan; Kirsch, Lawrence; Zanello, Dino; Lee-Franzini, Juliet; Loveless, Richard; McFadyen, John; Yarger, Harold. Phys. Rev. Lett., 16: 1224-8(June 27, 1966).

The interaction $\pi^+ + d \rightarrow p + p + \eta^0$ at 825 Mev and the subsequent decay $\eta^0 \rightarrow \pi^+ + \pi^- + \pi^0$ were investigated. It was observed that in the rest system of the meson (η^0), the meson (π^+) is on the average slightly more energetic than the meson (π^-) in the meson (η^0) decay. An asymmetry was noted in this decay which led to the conclusion that C invariance is violated in the 3π decay of the meson (η^0). (G.O.Y.)

34231 NEW STRUCTURE IN THE K^--p AND K^--d TOTAL CROSS SECTIONS BETWEEN 1.0 AND 2.45 Gev/c. Cool, R. L.; Giacomelli, G.; Kycia, T. F.; Leontic, B. A.; Li, K. K.; Lundby, A.; Teiger, J. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 16: 1228-32 (June 27, 1966). (BNL-10078).

The K^--p and K^--d total cross sections were measured in the momentum interval from 1.00 to 2.45 Bev/c. Preliminary analysis of the data obtained indicates two K^--N resonances above Y_0^* (1815) in the I = 0 state and very likely three K^--N resonances in the I = 1 state above Y_1^* (1765). (G.O.Y.)

34232 DETERMINATION OF THE PARITY OF Y_1^*(1660) BY STODOLSKY-SAKURAI PRODUCTION MODEL. Lee, Y. Y.; Reeder, D. D.; Hartung, R. W. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 17: 45-8(July 4, 1966). (COO-881-70).

The present experimental results bearing on the question of the parity of the Y_1^*(1660) are contradictory. Data supporting the $\frac{3}{2}^-$ spin-parity assignment based on the Stodolsky-Sakurai model of isobar production are presented. (auth)

34233 PROPOSAL TO TEST TIME-REVERSAL INVARIANCE IN THE REACTIONS $\gamma + d \rightleftharpoons n + p$. Barshay, S. (Rutgers State Univ., New Brunswick, N. J.). Phys. Rev. Lett., 17: 49-53(July 4, 1966).

It is suggested that a significant test of time-reversal invariance can be carried out by comparing the differential cross sections for the reactions $\gamma + d \rightarrow n + p$ and $n + p \rightarrow \gamma + d$ at, or above, about 290-Mev/c photon laboratory momentum, or about 590-Mev neutron laboratory kinetic energy, respectively, with unpolarized initial and final particles. (B.G.D.)

34234 RHO-MESON DIFFERENTIAL PRODUCTION CROSS SECTION BY 1.7-Bev/c π^-p INTERACTIONS. Allen, D. D.; Fisher, G. P.; Godden, G.; Kopelman, J. B.; Marshall, L.; Sears, R. (Univ. of Colorado, Boulder). Phys. Rev. Lett., 17: 53-6(July 4, 1966).

In a study of two-pronged events from 1.7-Bev/c π^- interactions in the 20 in. BNL hydrogen bubble chamber, it is shown that the three-body final state is dominated by

ρ-meson formation in a quasi-two-body channel. The data from 11,000 events were analyzed in such a way as to isolate the resonant state as freely as possible from nonresonant background to enable comparisons of various models in predicting ρ-production. (B.G.D.)

34235 CURRENT COMMUTATORS, REPRESENTATION MIXING, AND MAGNETIC MOMENTS. Harari, Haim (Stanford Univ., Calif.). Phys. Rev. Lett., 17: 56-9(July 4, 1966).

It was previously shown (Phys. Rev. Letters 16: 964 (1966)) that the positive-helicity state of the nucleon can be properly described as having components in the $\{(6,3)L_Z = 0\}$, $\{(3^*,3)L_Z = 0\}$, and $\{3,3\,L_Z = 1\}$ representations of $U(3) \otimes U(3)$, and that by adjusting one free mixing angle one can predict experimental values of G_A, the axial vector coupling constant in β decay; G^*, the strength of the axial-vector transition between nucleon and the N* (1238) resonance; and the d/f ratio for the axial-vector current between states of the baryon octet. Using the same assumptions and same mixing angle lead, in addition to a prediction for the ratio between the anomalous magnetic moment of the neutron and the strength of the magnetic transition between the nucleon and N* (1238). (B.G.D.)

34236 EXPERIMENTAL SEARCH FOR STABLE, FRACTIONALLY CHARGED PARTICLES. Chupka, W. A.; Schiffer, J. P.; Stevens, C. M. (Argonne National Lab., Ill.). Phys. Rev. Lett., 17: 60-5(July 4, 1966).

Various samples of matter were examined to search for stable quarks, particles of charge $\frac{1}{3}e$ or $\frac{2}{3}e$. The three materials examined were iron meteorites, air, and sea water; the concentrations of quarks were less than 10^{-17}, 5×10^{-27}, and 3×10^{-29} per nucleon. (auth)

34237 OBSERVATION OF THE TWO-PHOTON DECAY OF THE K_2^0 MESON. Criegee, L.; Fox, J. D.; Frauenfelder, H.; Hanson, A. O.; Moscati, G.; Perdrisat, C. F.; Todoroff, J. (Univ. of Illinois, Urbana). Phys. Rev. Lett., 17: 150-3(July 18, 1966).

An arrangement of spark chambers and scintillation showed detectors was used to investigate the two photon decay mode of the K_2^0 meson. The decay $K_2^0 \rightarrow 2\gamma$ was observed to occur with a branching ratio of $(1.3 \pm 0.6) \times 10^{-4}$. (B.G.D.)

34238 CP-INVARIANCE VIOLATION WITH $\Delta I > \frac{1}{2}$. Truong, Tran N. (Brown Univ., Providence). Phys. Rev. Lett., 17: 153-5(July 18, 1966).

The discovery of the decay mode $K_L^0 \rightarrow \pi^+ + \pi^-$ and subsequent experiments establish the violation of CP invariance in K^0 decay. The possibility that CP invariance holds for $\Delta I = \frac{1}{2}$ amplitudes and does not hold for decays which violate this rule is examined. The magnitude of CP-invariance violation is discussed and it is shown that the small value of $|\eta_{+-}|$ is probably accidental and that the present experimental data are consistent with a large CP-nonconserving $\Delta I > \frac{1}{2}$ amplitude. The measurement of $\pi^+\pi^-$ asymmetry in the decay $K_2^0 \rightarrow \pi^+ + \pi^- + \pi^0$ is suggested as a possible new test for CP-invariance violation. (B.G.D.)

34239 EVALUATION OF HIGH-ENERGY NATURAL NEUTRINO EXPERIMENTS. Cowsik, R.; Pal, Yash; Tandon, S. N. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect, A, 63: 217-43 (Apr. 1966).

The directional intensities of various types of neutrinos produced in the decay of secondary particle from cosmic-ray interactions in the atmosphere were calculated. The calculated energy spectra have an uncertainty of about 20% for neutrino energies up to 100 Bev. The energy spectra of neutrino-induced muons at large depths underground were also calculated. The detection of high-energy neutrinos from terrestrial sources is briefly discussed. (G.O.Y.)

34240 CP VIOLATION. Prentki, J. (CERN, Geneva). pp 176-204 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

A brief review is given of theories and models introducing new particles or fields that were proposed to explain the 2π decay of the long lived component K_L of the K_0, with intrinsic conservation of CP. It is indicated how these models have been excluded and how the situation has evolved in the direction of a general belief in the breakdown of CP invariance. Adopting the point of view that CP is violated and CPT is conserved, the question of where and how CP can be violated, and the experimental implications of the various models proposed in this context are examined. (L.B.S.)

34241 CP VIOLATION AND K DECAY. Steinberger, J. (CERN, Geneva). pp 205-47 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

A general treatment is given on CP violation and K decay, beginning with a list of the main decay modes and branching ratios, and a discussion on notation and the superposition principle. Following a discussion of CPT and CP invariance experiments on 2π decay are reviewed. The interference of K_S and K_L in 2π decay, CP violation and $\Delta S = \Delta Q$ rule in K^0 leptonic decay, and conditions imposed by unitarity and CPT on CP violating amplitudes are treated. (L.B.S.)

34242 PROTON-ANTIPROTON ANNIHILATIONS AT REST. Franzini, P. (Columbia Univ., New York). pp 248-74 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

The statistical model formulation of Srivastava and Sudarshan is outlined for the $\bar{p}p + p \rightarrow n\pi$ interaction, and discrepancies between experimental values and predictions of the model are pointed out. A series of experimental results are presented on $\bar{p}p$ annihilations at rest and a phenomenological analysis is made of some final states, which yields information of the symmetry properties of the interaction and strongly suggest that some selection rules, in addition to the well-established ones, may be involved. (L.B.S.)

34243 LOW-ENERGY HYPERON-PROTON INTERACTIONS. Snow, G. A. (Univ. of Rome). pp 288-97 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

A general qualitative discussion is given on the low-energy hyperon-proton interactions from the experimental point of view, along with some theoretical predictions of SU(3) and SU(6). The difficulties of comparing these symmetry schemes with experiments dealing with two-particle scattering are illustrated. (L.B.S.)

34244 STRANGE RESONANCES. Focardi, S. (Univ., Bologne). pp 298-317 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

New results of bubble chamber experiments on the production of strange mesonic and baryonic resonances are summarized. The methods generally used in the analysis of experimental data are described, and several examples are noted. (L.B.S.)

34245 INVITED DISCUSSION FOLLOWING THE FOCARDI LECTURE. Henri, V. P. (CERN, Geneva). pp 318-22 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

Remarks are given concerning the production of K*(1400) and K**(1320), which refer to results presented at the Oxford International Conference on Elementary Particles (1965). (L.B.S.)

34246 CURRENT EXPERIMENTS AT DESY. Meyer-Berkhout, U. (DESY, Hamburg). pp 323-59 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

The current experimental program at the 6 Bev electron accelerator at Hamburg is outlined, which includes bubble-chamber experiments, electron-scattering experiments, investigations of photoproduction processes, and experiments on bremstrahlung production and synchrotron radiation. Some preliminary results obtained during the first year of machine operation are summarized. (L.B.S.)

34247 ELECTRON SPECTRUM FROM MUON DECAY. Lee-Franzini, J. (State Univ. of New York, Stony Brook).

pp 360-9 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

The reaction $\mu^+ \rightarrow e^+ + \nu_e + \bar{\nu}_\mu$ is investigated within the framework of the current-current local interaction theory. An expression is obtained from the local effective interaction for the electron spectra in terms of the electron momentum and the Michel parameter. An improved measurement of the Michel parameter was undertaken in view of the possible existence of a vector boson W coupled to the weak current, which produces a small deviation from the electron spectra for a strictly local interaction. The experiment is described, which combines various features of the spectrometer method and the visual method. A value of 52.81 ± 0.02 Mev/c was obtained for the maximum electron spectrum, which is compared with that of 52.83 Mev/c for the theoretical spectrum. A χ^2 fit to the data gives a value of 0.747 ± 0.005 for the Michel parameter. (L.B.S.)

34248 SLOW GROUND STATE ELECTRONS AND THE ANOMALOUS MAGNETIC MOMENT OF THE FREE ELECTRON. Knight, Larry Vinson. Stanford, Calif., Stanford Univ., 1965. 97p.

Thesis.

Previous g-2 experiments on the free electron are reviewed. It is concluded that an experiment proposed by Bloch offers the possibility of the highest precision conceptually. Bloch proposed a magnetic resonance experiment on magnetic ground state electrons separated from the excited state electrons. Experimental evidence is reported that indicates that ground state electrons have been separated in time from all other electrons in a pulsed beam of electrons. These slow ground state electrons are guided by an axial magnetic field through a copper drift tube in an ultrahigh vacuum at low temperatures. Results attributed to electrons that have fallen into traps in the potential of the drift tube are discussed and analyzed. The mechanism for trapping and escape from the trap is discussed. A magnetic field gradient in the center of the drift tube was used to change the magnetic energy of ground state electrons as they passed through the drift tube. This analyzing magnetic field changes the distribution of the electrons with time of flight. Since the shape of the distribution curve of electrons with time of flight depends on g-2, a measurement of $a = g-2/a$ can be made from the data. The result is $a = .001 \pm .0003$. A novel method for the measurement of the energy distribution of the electrons emitted from a tunnel cathode is described and demonstrated. A magnetic resonance g-2 experiment that uses slow ground state electrons is described in detail. The analysis of this proposed experiment indicates that a possible measurement of 1 part in 10^8 of g-2 is possible. The possibility of future experiments on electrons and positrons is discussed. (TCO)

34249 RESONANCE ANALYSIS IN K^+p REACTIONS AT 2.26 Bev/c. Bomse, Frederick M. Baltimore, Johns Hopkins Univ., 1965. 254p.

Thesis.

The reactions between K^+ mesons and protons at an incoming K^+ laboratory momentum of 2.26 Bev/c are investigated. Of primary interest is the production of the K* (890) and N* (1238) resonances in the channels $K^+p \rightarrow K^*p \rightarrow K^0\pi^+p$ (I), $K^+p \rightarrow K^0N^* \rightarrow K^0\pi^+p$ (II), and $K^+p \rightarrow K^*N^* \rightarrow K^+\pi^-\pi^+p$ (III). It is found that the first two of these reactions are consistent with a model that assumes that they proceed by exchange of a vector meson, while the third is consistent with a pseudoscalar meson exchange model. These theoretical exchange models are best corroborated by the data in the area of decay angular distributions of the resonances. The experimental differential cross sections are also in fair agreement with exchange model theory. A systematic search is made in the reaction $K^+p \rightarrow K^+\pi^-\pi^+p$ for the production of new resonances. A Monte Carlo calculation with which the experimental results may be compared is utilized. No evidence for the production of further resonances is observed in this channel. The five-particle reaction $K^+p \rightarrow K^+\pi^-\pi^+p\pi^0$ is also investigated with the help of Monte Carlo techniques. It is found that the four-body reaction $K^+p \rightarrow K^+\pi^-\pi^+p$ is often interpreted by the kinematic fitting program KICK as the above five-body reaction in which a $K^+\pi^0$ resonance is simulated. Otherwise, no evidence for resonances is found in this five-body channel. Cross sections for the reactions are also determined and compared with other experiments at different energies. The present results are 0.61 ± .06, 0.64 ± .06, and 0.76 ± .07 mb for reactions (I), (II), and (III) respectively. (Dissertation Abstr.)

34250 PHOTOPRODUCTION AND ELECTROPRODUCTION OF PIONS IN THE REGION OF THE N*(1238). Zagury, Nicim. San Diego, Calif., Univ. of California, 1965. 73p.

Thesis.

The photoproduction and electroproduction of pions is treated relativistically. A new solution for the 3-3 amplitudes is obtained which includes recoil and is insensitive to a cutoff. Corrections to the E_{0+} and M_{1-} amplitudes are evaluated by using fixed-t dispersion relations. Good results are obtained in the region around the 3-3 resonance up to π-N center-of-mass energies around 1350 Mev and electron momentum transfer up to 3.8 Bev^2/c. (Dissertation Abstr.)

34251 K* RESONANCE. Payne, George Page. University Park, Pa., Pennsylvania State Univ., 1965. 53p.

Thesis.

A calculation of the mass, 890 Mev, and width, 50 Mev, of the K* resonance, occurring in π-K scattering was performed with the Balazs approximation to the N/D equations was shown that the K* resonance can be understood in a bootstrap approach. The main forces binding the K* are due to the exchange of the ρ and the f^0 particles. The strength of these forces are in term due to the exchange of the K* resonance. A self-consistent solution yields a resonance in the πK scattering amplitude in 750 Mev with a width of 90 Mev. These values are good in the present state of development of strong interaction theory. (Dissertation Abstr.)

34252 PHOTOPRODUCTION OF K^+ MESONS IN HYDROGEN AT 1400 Mev. Stanton, Noel Russell. Ithaca, N. Y., Cornell Univ., 1965. 120p.

Thesis.

Measurements were made of the angular distribution of K^+ mesons in the reaction $\gamma + p \rightarrow K^+ + \Lambda^0$ at a photon energy of 1400 Mev. Differential cross sections were obtained at nine center-of-mass angles between 17.5° and 142.5°. Although the angular distribution is very similar in appearance to that obtained earlier at photon energies between 1054 and 1160 Mev, it does not show the sharp rise at angles smaller than 30° observed by Peck at 1200 Mev, but remains almost constant in this angular interval (data were taken at angles smaller than 30° only at 1200 and 1400 Mev). The cross section at 90° is, within experimental errors, constant from about 1000 to 1400 Mev. The K mesons are detected by two spectrometers working simultaneously but independently on different portions of the angular distribution. One spectrometer remains fixed at the largest K-meson production angle throughout the experiment because of the low counting rate encountered there. The other spectrometer obtains data sucsively at center-of-mass angles between 17.5° and 90°. K mesons are identified by magnetic momentum analysis and velocity selection by means of threshold Cherenkov counters and measurement of time-of-flight. A summary of past and current theoretical work in K-meson photoproduction is presented. Although none of the theoretical papers published to date make explicit predictions for photon energies as high as 1400 Mev, calculations currently being performed by H. T. Edwards indicate that it is difficult to fit both the previous data (taken at photon energies between 975 and 1200 Mev) and the results of this experiment by assuming only those processes invoked in the past to explain the low-energy data. (Dissertation Abstr.)

34253 K^+-d SCATTERING. Chand, Ramesh (Wayne State Univ., Detroit). 12p. (CONF-660107-25). ORAU. Gmelin, AED-CONF-66-003-63.

From American Physical Society Meeting, New York.

The reactions $K^+ + d \rightarrow K^+ + d$ (elastic), $K^+ + d \rightarrow K^+ + n + p$ (disintegration), and $K^+ + d \rightarrow K^0 + p + p$ (charge exchange) were investigated to determine whether the I = 0, s-wave KN nuclear potential is attractive or repulsive and whether one can determine the I = 0, s-wave KN scattering parameters. (B.G.D.)

34254 EVIDENCE FOR DEVIATIONS FROM ONE-PION EXCHANGE MECHANISM IN ρ^- PRODUCTION. Blieden, H. R.; Focacci, M. N.; Dubal, L.; Kienzle, W.; Lefebvres, F.; Levrat, B.; Maglic, B. C. (CERN, Geneva). 13p. (CONF-660107-24). ORAU. Gmelin, AED-CONF-66-003-54.

From American Physical Society Meeting, New York.

The data obtained with a modified missing-mass spectrometer (Blieden et al., Phys. Letters Nov. 15, (1965)) at 3.0 ± 0.1 and 3.5 ± 0.1 Bev/c on ρ^- production in the reaction $\pi^- + p \rightarrow p + \rho^-$ are analyzed in terms of θ^* and ϕ, where θ^* is the angle between incident π^- and the decay π^- measured in the rest frame of the ρ^- and ϕ is the Treiman-Yang angle. (B.G.D.)

34255 POSITRON LIFETIMES VS. TWO GAMMA CORRELATIONS IN THE ALKALI METALS. Terrell, J. H.; Weisberg, H. L.; Berko, S. (Brandeis Univ., Waltham, Mass.). 13p. (CONF-650721-19). ORAU. Gmelin, AED-CONF-65-211-20.

From Positron Annihilation Conference, Detroit.

An attempt is made to reconcile the positron lifetime and two gamma correlation aspects of positron annihilation in Li, Na, K, and Cs. (B.G.D.)

34256 EXPERIMENTAL EVIDENCE OF BARYON EXCHANGE IN K^- PROTON INTERACTIONS AT 3 Gev/c. Badier, Jean (Ecole Polytechnique, Paris). 18p. (CONF-660107-40). ORAU. Gmelin, AED-CONF-66-003-90.

From American Physical Society Meeting, New York.

An analysis is presented of 25,000 events of the K^-p interaction at 3 Bev/c performed in the CERN hydrogen bubble chamber. From the point of view of the angular distributions at the production the following points are considered: backward peak of the baryon (explained by one meson exchange); forward peak of baryon (explained by baryon exchange); and both backward and forward peaks (explained by superposition of two exchange processes or possibility of a resonance formation). The angular distribution of the Y_1^* (1520) is given as an example of the experimental method. (B.G.D.)

34257 ELECTRON SCATTERING: POSSIBLE DEVIATIONS FROM ELECTRODYNAMICS. Margolis, B. (McGill Univ., Montreal). 14p. (CONF-650653-19). ORAU. Gmelin, AED-CONF-65-170-33.

From American Physical Society, Summer Meeting, New York.

A discussion is presented on electron and positron scattering by nuclei, nucleons, and by electrons and positrons. Included also is the $e^\pm$ or $\mu^\pm$ pair production in a Coulomb field or in the field of the nucleus, the initiating particle being a photon. (B.G.D.)

Field Theory, Scattering Theory, and Symmetries

See also Elementary Particles and Radiations

Refer also to abstract 34594.

34258 (IC-66/60) BOUND-STATE EQUATION FOR QUARK-ANTIQUARK SYSTEM. Delbourgo, R.; Salam, Abdus; Strathdee, J. (International Centre for Theoretical Physics, Trieste (Italy). Imperial Coll. of Science and Tech., London (England)). June 1, 1966. 23p. Dep. mn.

The relativistic bound state (Bethe-Salpeter) equation for quark-antiquark binding with a specific kernel corresponding to a zero boson-singlet exchange is treated explicitly with a view to seeing if one can reproduce the meson multiplet spectrum assigned by the higher symmetry schemes. (M.O.W.)

34259 (IC-66/66) MESON-BARYON COUPLING CONSTANTS IN BROKEN SU(3) AND THE ALGEBRA OF CURRENTS. Bose, S. K.; Hara, Y. (International Centre for Theoretical Physics, Trieste (Italy)). 1966. 9p. Dep. mn.

Renormalization effects due to SU(3) breaking on the meson-baron coupling constants are studied using algebra of currents. (auth)

34260 (IC-66/69) ELECTROMAGNETIC FORM FACTORS FROM THE LOCALITY OF CURRENT DENSITIES. Oehme, R. (International Centre for Theoretical Physics, Trieste (Italy)). June 1966. 7p. Dep. mn.

It is shown that the successful results of collinear groups for electromagnetic form factors can be obtained on the basis of the locality of current density commutators and SU(3) invariance, provided only matrix elements of the commutators with $\Delta T_z = 0$ are considered in the saturation. The necessity of leakage in $\Delta T_z \neq 0$ matrix elements is discussed briefly. (auth)

34261 (JINR-P-2697) ANALITICHESKIE SVOISTVA AMPLITUDY RASSEYANIYA SLOZHNOI CHASTITSY NA SILOVOM TSENTYE. (Analytical Properties of Scattering Amplitude of a Complex Particle on the Force Center). Khelashvili, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 12p. Dep. mn.

On the basis of a "generalized potential" obtained in the previous paper, the analytical properties of the scattering amplitude of a complex particle on the force center in energy and momentum transfer were investigated for the S-wave case. (auth)

34262 (ORO-2915-44) INDUCED CP VIOLATION IN NON-LEPTONIC $\Delta T = \frac{1}{2}$ TRANSITIONS. Pietschmann, Herbert V. R. (Virginia Univ., Charlottesville. Dept. of Physics). July 1965. Contract AT(40-1)-2915. 6p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A mechanism is pointed out by which CP-violation is inevitably induced in nonleptonic $\Delta T = \frac{1}{2}$ transitions. This is independent of the choice of the fundamental mechanism for CP-violation in neutral K-decays. (M.O.W.)

34263 (UCRL-14920-T) COMPARISON OF THE ENERGY EIGENVALUE EQUATIONS FOR SPINS 0, 1/2, AND 1 FOR SPHERICALLY SYMMETRY POTENTIALS. Fritz, Karl (Lawrence Radiation Lab., Univ. of California, Livermore). May 20, 1966. Contract W-7405-eng-48. 13p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Some well known relations for spin 0 and spin 1 wave functions are compared to the analogous relations for spin $\frac{1}{2}$. In particular, the algebra of the matrices used to linearize the Klein-Gordon equation, the explicit linearization procedure used, and the singularity introduced by a Coulomb potential are considered. (auth)

34264 IMPLICATIONS OF THE ALGEBRA OF CURRENTS APPROACH TO HIGHER SYMMETRIES. Ryan, C. (Univ. of Rochester, N. Y.). Ann. Phys. (N. Y.), 38: 1-27(June 15, 1966). (UR-875-101).

The implications of the algebra of currents approach to higher symmetries are studied in the case of the SU(4) higher symmetry group. The commutator algebra of integrated current operators and the manner in which it is employed to deduce results normally ascribed to a higher symmetry group are discussed. Various simple cases of the method are considered for the purpose of elucidating its hidden consequences. Particular attention is given to the role of the angular momentum in the whole procedure and to the question of using zero momentum as against nonzero momentum states. (auth)

34265 RELATIVISTIC SPIN AND EULER ANGLES. Sparzani, A. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Ann. Phys. (N. Y.), 38: 28-34(June 15, 1966).

The Bargmann-Wigner equations for particles of mass $m \neq 0$ spin $s \neq 0$ are derived from a set of equations involving differential operators only. To this aim, an expansion of the wave function with respect to a suitable set of functions of Euler angles is utilized. (auth)

34266 INELASTIC LEVINSON'S THEOREM, CDD SINGULARITIES, AND MULTIPLE RESONANCE POLES. Hartle, James B.; Jones, C. Edward (Stanford Univ., Calif.). Ann. Phys. (N. Y.), 38: 348-62(June 27, 1966). (SLAC-PUB-129).

Some effects of inelastic channels on elastic partial-wave amplitudes are discussed. A Levinson's theorem for both the real part of the phase shift and the total phase of the elastic amplitude is derived. The CDD singularities required to make the elastic amplitude calculated by single-channel inelastic N/D equations agree with the many-channel calculation without CDD singularities are fully characterized in both the η and R methods. Finally, a simple explanation of multiple resonance poles on different Riemann sheets of the amplitude is given in terms of the analyticity properties of η. (auth)

34267 REALIZATION OF HAAG'S THEOREM IN THE SCATTERING THEORY. Garczynski, W. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 14: 209-14(1966).

The theory of a neutral scalar field A(x) is considered for the case of the Jost model B(x), where $B(x) = \int A(x - \xi)h(\xi^2)d^4\xi$. A separable Hilbert space with a positive-definite metric is assumed ($\overline{D} = H$, D a countable set), and a unitary representation U(a,Λ) of the proper Poincaré group on D is defined. A linear mapping $W_\pm(t)$ of H_t on $H_\pm$ is defined and written in canonical form in terms of $R_\pm(t)$, a self-adjoint and positive-definite operator in H_t, and $U_\pm(t)$, an isometric mapping of H_t into H_+, H_-, correspondingly. The theorem that, if $R_+(\tau) = 1$ or $R_-(\tau) = 1$ (i.e., $H_\tau = U_\mp^{-1}(\tau)H_\pm$) for some finite τ, then $S(A) = 1$, and hence the theory is trivial is proved by showing two equalities between the Wightman functions. The field A(x) is identified with some known trivial fields. (M.J.T.)

34268 POSSIBLE UNIFICATION OF THE INTERNAL AND EXTERNAL MOVEMENTS OF ELEMENTARY PARTICLES DESCRIBED AS ISOMETRIC MOVEMENT GROUPS OF DISPLACEMENT ON RIEMANN VARIETIES. Vigier, Jean-Pierre (Institut Henri Poincare, Paris). Compt. Rend., Ser. B, 262: 1239-41(May 9, 1966). (In French).

A new model of elementary particles is proposed, comparing them in accordance with the concepts of Einstein and of de Broglie to hypertubes in the V_5 varieties of Riemann. The internal movement groups [SU(2,1)] and external groups (Poincaré) of isometry are unified on the isometric front in the framework of the Lie algebra of the conform group SU(2,2). The essential ideas of general relativity are thus extended to distances $<10^{-13}$ cm. (tr-auth)

34269 ON THE YANG-MILLS FIELD. Toro, Tiberiu I. (Univ., Timisoara, Roumania). Compt. Rend., Ser. B, 262: 1413-16(June 1, 1966). (In French).

The compensator field of Yang and Mills and its generalization given by Glashow and Gell-Mann are analyzed. By using the results of a previous study, an extension is made for the nonlocal case of the nonabelian group of Yang-Mills generalized in the Glashow-Gell-Mann sense. (tr-auth)

34270 A CONTRIBUTION TO THE THEORY OF THE SU_6 SYMMETRY OF ELEMENTARY PARTICLES. Novozhilov, Yu. V.; Terentev, I. A. (Zhdanov Leningrad State Univ.). Dokl. Akad. Nauk SSSR, 165: 800-2(Dec. 1, 1965). (In Russian).

In order to obtain an S matrix with a relativistic SU_6 symmetry, a unitary representation of the inhomogeneous $P(SU_6)$ group, of which SU_6 is a subset, must be prepared. Study of the algebra of $P(SU_6)$ generators indicated that conclusions concerning permuted relations may be generalized for the case of $P(SU_r)$, for which SU_r is a subset. In order to compare the relative SU_6 symmetry with the SU_r symmetry, the relations were computed for an arbitrary value of r. The Poincare set is a partial case of $P(SU_r)$ for r = 2. A formula was derived for solving the Wigner operator problem for the case of the $P(SU_r)$ set. By means of this operator it is possible to obtain the equation of motion in another form and under other conditions. The operator is also of special importance for investigating the Bargman-Wigner type equations of motion and for determining the covariant vector B_α which enters into the $B_\alpha P_\alpha = \varkappa^2$ invariant. (TTT)

34271 ON THE DOMAIN FREE OF RESONANCE POLES IN THE PROBLEM OF SCATTERING BY A THREE-DIMENSIONAL POTENTIAL. Ramm, A. G. Dokl. Akad. Nauk SSSR, 166: 1319-22(Feb. 21, 1966). (In Russian).

In connection with scattering of particles by a three-dimensional potential, the Schrödinger equation $\Delta u + k^2u - V(x)u = 0$, $x = (x_1, x_2, x_3)$, is analyzed under the assumption that the potential V(x) is a differentiable, finite function. It is proven that the solution u(x, k) of the equation has an analytic continuation in the entire plane of the complex variable $k = \sigma + i\tau$. This continuation is regular in the half-plane Im $k \geq 0$. It is established that the poles of the function u(x, k) (the wave function) are located in the plane Im $k < 0$ and for large σ values they are under the curve $\tau = -a \ln|\sigma| + b$, where $a > 0$ and b are certain constants. It is noted that since the poles of the scattering amplitude coincide with the poles of the wave function u(x, k) the derived results can be extended to the scattering amplitude. The problem of the analytic continuation of the wave function is also considered in the case when instead of the finiteness of the potential, the condition $\int e^{-a|x|}|V(x)|dx < C(a)$, C(a) = const, where $a > 0$ is an arbitrary number, is satisfied. (ATD)

34272 APPROXIMATE METHOD OF CALCULATING THE S MATRIX. Kushnirenko, A. N. (Inst. of Problems in Material Studies, Academy of Sciences, Ukr. SSR). Dopov. Akad. Nauk Ukr. RSR, No. 5, 600-4(1966). (In Russian).

A method is described for calculating scalar products (Ψ_k, Ψ_m) encountered in the approximate calculation of the S-matrix. (auth)

34273 EQUIVALENCE OF METHODS FOR DETERMINING THE PRESENCE OF A MASSLESS PARTICLE. Guralnik, G. S. (Univ. of Rochester, N. Y.). Nuovo Cimento (10), 44A: 321-9(July 21, 1966). (UR-875-104).

It is demonstrated that Streater's proof of the relation between spontaneously broken symmetries and zero-mass particles is equivalent to the usual one. Several models are given to illustrate this equivalence. (auth)

34274 MASS SPLITTING IN $\tilde{U}_{12}$? Williams, D. J. (Clarendon Lab., Oxford). Nuovo Cimento (10), 44A: 330-5(July 21, 1966).

A general mass-splitting operator is considered for $\tilde{U}_{12}$. It is shown to lead to linear mass formulas for the baryons, and under reasonable assumptions, also for the mesons. It is observed that experimental masses satisfy quadratic mass relations for both mesons and baryons as suggested by a quark model. It is therefore concluded that $\tilde{U}_{12}$ is not in agreement with experiment in this respect. (auth)

34275 SU_9 COMPOSITE SYMMETRY AND WEAK INTERACTIONS. Cocho, G. (International Centre for Theoretical Physics, Trieste). Nuovo Cimento (10), 44A: 336-62(July 21, 1966).

An SU_9 composite symmetry model is considered. A $U_9 \times U_9$ group and a relativistic boosting are also discussed. Within such SU_9 composite model, assuming that in the nonleptonic decays the weak hamiltonian transforms as the central component of the $SU_3(S, B)$ octet of the $(9,\bar{9})$ representation of $U_9 \otimes U_9 \supset SU_3(S, B) \otimes SU_3(T, Y)$, the scalar-pseudoscalar mixing is fixed to be $\sqrt{2/3}S - \sqrt{1/3}P$. With essentially one parameter a reasonable fitting is obtained for both nonleptonic decays of hyperons and $K_1 - \pi + \pi$ decay. If it is assumed that in the leptonic decays such scalar-pseudoscalar mixing is reflected in the vector-axial vector ratio, it also follows that $|g_A/g_V| = 5/3\sqrt{2}$. (auth)

34276 DISCONTINUITY FORMULA FOR PHYSICAL-REGION SINGULARITIES. Boyling, J. B. (Cambridge Univ., Eng.). Nuovo Cimento (10), 44A: 379-89(July 21, 1966).

The methods of homology theory are applied to an analytic function defined initially as the integral of an analytic function over a compact subset of a submanifold of a real Euclidean space whose boundary is piecewise analytic. Under the assumption that the integrand is meromorphic and only has simple poles a discontinuity formula is established for real singularities of the integral corresponding to simple pinches involving the poles of the integrand and the boundary surfaces of the region of integration. It is argued that this formula still applies when the integrand has other singularities provided none of these participates in the pinch. The formula is then generalized to the case of a simple pinch involving branch-point singularities as well as simple poles and boundary surfaces, and the modifications necessary when the integrand has branch-point singularities on its boundary surfaces are discussed. (auth)

34277 NONRELATIVISTIC MODELS OF STABLE COMPOSITE PARTICLES. Jacquemin, A. (College de France, Paris). Nuovo Cimento (10), 44A: 390-410 (July 21, 1966). (In French).

In a previous paper two kinds of composite particles, called H and X were introduced, according to the nature of the coupling between the particles which generate it. In the framework of potential theory restricted to the regular case, a more precise formulation of the two models is given and analyzed from a field-theoretical point of view and by the N/D method. For the H particle (s-wave bound state) two definitions of the vertex and the propagator are considered. One is derived from the decomposition of the s-wave scattering H amplitude, $T_H = T_X - g^2\Gamma_H^2\Delta_H$, but its physical interpretation is obscure: both vertex and propagator depend on an arbitrary parameter related to the location of the T_X pole (this pole exists for any value of the parameter and coincides with the vertex pole); the H particle mass and coupling constant satisfy $Z_3^{(\mu)}(g^2) = 0$ and $\delta v^{2(\mu)} = 0$ (this last equation implies necessarily $Z_1^{(\mu)} = 0$). The other definition is derived from the $m \to \mu$ limit of the X amplitude (m = mass of the X composite particle); in this limit, equivalent to $Z_3^{(m)} \to 0$, both the vertex as the inverse of the propagator are null. The parameters of the H particle are fixed by the two conditions $Z_3^{(\mu)} = 0$ and $Z_1^{(\mu)} = 0$. For the X composite particle there exists only one relation between the mass and coupling constant; for one given m, the coupling constant is determined by $Z_3^{(m)}(g_X^2) = 0$. Another distinction appears from the N/D equations defining the scattering amplitude: the T_H amplitude is solution of unsubtracted equations, while the T_X amplitude is constructed from subtracted ones. The differences in the asymptotic behavior of the scattering amplitudes and in the shape of the Regge trajectories are analyzed, which could allow the discrimination of the two kinds of composite particles. (auth)

34278 AXIAL VECTOR FORM FACTORS AND ELECTROPRODUCTION SUM RULES. Furlan, G. (Univ., Trieste. Istituto Nazionale di Fisica Nucleare, Trieste); Jengo, R.; Remiddi, E. Nuovo Cimento (10), 44A: 427-39 (July 21, 1966).

Using a dispersive representation for the equal-time commutators of the $SU_2 \otimes SU_2$ algebra a sum rule is obtained for the axial vector form factor $G(\Delta^2)$, which can be expressed in terms of the vector form factor $F_1^V(\Delta^2)$ and of the imaginary part of the electroproduction amplitude. (auth)

34279 RENORMALIZATION OF WEAK VECTOR COUPLING CONSTANTS DUE TO SYMMETRY-BREAKING CORRECTIONS. Matsuda, S. (Tokyo Univ.). Nuovo Cimento (10), 44A: 448-58(July 21, 1966).

Assuming that the particles' hamiltonian contains a symmetry-breaking interaction transforming like the eighth component of an SU_3 octet, the extent to which the strangeness-changing weak vector coupling constants for the hyperons are renormalized as a consequence of the symmetry breaking is calculated, making use of the Fubini-Furlan-Adler-Weisberger technique. The results obtained are shown. The application to the calculation of the renormalization of the strangeness-changing weak vector currents for the pseudoscalar mesons is also discussed. (auth)

34280 THEORY OF WEAK INTERACTIONS. Das, T.; Mahanthappa, K. T. (Univ. of Pennsylvania, Philadelphia). Nuovo Cimento (10), 44A: 469-83(July 21, 1966).

The possibility of the existence of an SU_3-symmetric structure of weak interactions is investigated. For this purpose all weak interactions are viewed as taking place in a "weak" SU_3-space which has "weak" isotropic spin I' and "weak" hypercharge Y' as its conserved quantities. The eigenstates of I' and Y' are formed out of mixing the physical particle states which are the octets of hadrons and the (postulated) triplets of leptons. All weak interactions now consist of a weak SU_3-symmetric part and a part which is asymmetric along the weak hypercharge axis. All the well-known results of the weak decays are derived and the suppression of $|\Delta S| = 1$ and $\Delta I = 3/2$ and $|\Delta S| = 2$ decays is naturally explained. No use is made of the hypothesis of current-current interaction and octet dominance. (auth)

34281 TWO ELEMENTARY PARTICLES AND THE CONDITION DET Z = 0. Houard, J. C. (College de France, Paris); Le Guillou, J. C. Nuovo Cimento (10), 44A: 484-503(July 21, 1966). (In French).

A study is made of the renormalization of a system in which two elementary particles with the same quantum numbers are interacting with a single pair of bosons. The compositeness condition is then obtained for one of these particles in the form Det Z = 0, where Z is the matrix of the wave-function renormalization constants. This allows the compositeness concept to be defined for such a case in the framework of field theory. The field operators are explicitly exhibited in the Det Z = 0 limit. The general structure of the scattering amplitudes is then analyzed, and the amplitudes and their decompositions obtained by the N/D method are interpreted in field theory. (auth)

34282 VANISHING OF THE VERTEX RENORMALIZATION CONSTANT IN FIELD THEORY. Choudhury, S. Rai (Moscow State Univ.). Nuovo Cimento (10), 44A: 522-5 (July 21, 1966).

The implications and conditions of vanishing of the vertex renormalization constant for elementary particles are examined, and the relation with the definition of bound states is established. (L.B.S.)

34283 OCCURRENCE OF AN SU_3 REPRESENTATION IN THE DECOMPOSITION OF A DIRECT PRODUCT: BOUNDS AND MULTIPLICITY. Bergia, S.; Zalewski, K. (CERN, Geneva). Nuovo Cimento (10), 44A: 542-5 (July 21, 1966).

A method is presented for determining whether a representation D(p,q) occurs in the decomposition of the direct product $D(p_1,q_1) \times D(p_2,q_2)$ of two SU_3 representations and for computing its multiplicity without performing the complete reduction. It is also shown that the number of times D(p,q) can occur in the decomposition is intrinsically bounded. (L.B.S.)

34284 SATURATION OF CHIRAL U(3) x U(3) ALGEBRA. Cabibbo, N.; Ruegg, H. (CERN, Geneva). Phys. Lett., 22: 85-7(July 15, 1966).

Conditions for saturation of chiral SU(3) × SU(3) algebra are studied. The relation between G_A/G_V and D/F is computed requiring saturation of the algebra in a set of baryons composed of a "56" and a choice of different states. (auth)

34285 QUARK MODEL AND RELATIONS BETWEEN HIGH-ENERGY SCATTERING AMPLITUDES. Kokkedee, J. J. J. (CERN, Geneva). Phys. Lett., 22: 88-9(July 15, 1966).

Further consequences are discussed of a simple quark model for high energy scattering based on the additivity assumption for quark amplitudes. (auth)

34286 REGGE POLE MODEL OF QUARK-QUARK AMPLITUDES AND TOTAL CROSS SECTIONS OF THE

HADRONS. Ahmadzadeh, A. (Univ. of California, San Diego, La Jolla). Phys. Lett., 22: 96-9(July 15, 1966). (UCSD-10P10-1).

It is shown that one can easily accommodate the quark decomposition hypothesis in the Regge-pole model. In so doing a five parameter set of equations is obtained which gives a quantitative description of all the known high energy meson-baryon and baryon-baryon total cross sections. (auth)

34287 NECESSITY OF FIELD DEPENDENCE FOR INTERACTING CURRENTS. Boulware, D. (Univ. of Washington, Seattle); Deser, S. Phys. Lett., 22: 99-101 (July 15, 1966).

It is shown that the vanishing of the equal time commutators of axial, vector or tensor currents (conserved or not) with the canonical fields to which they couple implies the vanishing of the interaction. (auth)

34288 SCATTERING OF ELECTROMAGNETIC WAVES IN A SPINOR FORMALISM. Rockmore, R. M. (Rutgers Univ., New Brunswick, N. J.). Phys. Rev., 147: 899-905(July 29, 1966).

The scattering of electromagnetic waves by weak scatterers is discussed in terms of a six-component-spinor formulation of the electromagnetic field. In particular, expressions are derived for the scattering amplitude which are appropriate to small- and large-angle regimes of high-energy scattering. Comparison with the earlier work of Überall, who applied the Saxon-Schiff theory to the same problem, is made. (auth)

34289 COMPARISON OF THREE SPIN ALGEBRAS EMPLOYED IN SU(6) THEORIES. Casella, R. C. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 147: 962-4(July 29, 1966).

The Lipkin-Meshkov (LM) W spin, Foldy-Wouthuysen (FW) mean spin, and an algebra constructed from the four generators of the Wigner little group provide SU(2) algebras which can be embedded in an SU(6) description of moving hadrons. It is shown that when acting on particle states obeying the Dirac equation, all three are identical. Differences occur with regard to behavior under charge conjugation. In particular, the FW spin acts on particles and antiparticles alike and, in the quark model, does not lead to the LM spin flip between the vector and pseudoscalar mesons. (auth)

34290 SU(6) ALGEBRA OF GELL-MANN: MASS SPLITTINGS AND NONLEPTONIC DECAYS OF HADRONS. Riazuddin; Mahanthappa, K. T. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 147: 972-7(July 29, 1966).

The SU(6) algebra of Gell-Mann is applied to nonleptonic decays of hadrons. It is assumed that the weak-interaction Hamiltonian for s-wave decays transforms like S_7^8 (the seventh component of the space integral of the pseudoscalar quark density). Using the Fubini-Furlan-Adler-Weisberger technique and the partially conserved axial-vector current, the s-wave decay amplitudes are expressed in terms of the reduced matrix elements, which are the same as the ones that appear in the expression for mass splittings if one assumes that the symmetry-breaking part of the mass operator transforms like S_8 (the eighth component of the space integral of the scalar quark density). Making use of the fact that the mass-splitting parameter is universal, and assuming that the s-wave coupling constant G_s is also universal, a ratio $(K_1^0 \to 2\pi)/A(\Sigma^-)$ is predicted, which is in excellent agreement with experiment. Knowing any one of the hyperon s-wave decay amplitudes one can predict the others. The implications of these results are discussed. (auth)

34291 CONSEQUENCES OF THREE DISCRETE INTERNAL SYMMETRY TRANSFORMATIONS FOR LEPTONS. Barut, A. O. (Univ. of Colorado, Boulder). Phys. Rev., 147: 978-9(July 29, 1966).

The inequivalent irreducible ray representations of three discrete exchange operators give exactly four pairs of states and account uniquely for the leptonic states and leptonic quantum numbers. The distinction between the symmetry group of the multiplets and the symmetry group of the S matrix is discussed. (auth)

34292 EXACT SOLUTION OF THE ONE-PHOTON-EXCHANGE N/D EQUATIONS. Halpern, M. B. (Univ. of California, Berkeley); Rix, J. Phys. Rev., 147: 984-92 (July 29, 1966).

The exact solution of the single-Yukawa-meson-exchange N/D equations is obtained in the zero-meson-mass (Coulomb) limit. The solution sums an infinite series of infrared-divergent ladder-graph fragments into finite, unitary partial-wave amplitudes. As with the Schrödinger equation for the hydrogen atom, one finds an infinite number of bound states (zeros of the D function) with an accumulation point at threshold. These bound-state poles of the scattering amplitude arise from the long-range force in much the same way as dynamical bound states arise generally in dispersion theory, thus allowing a discussion of the long-range force rather naturally in the usual dispersion-theoretic terms. The bound-state poles are neither so deeply bound nor so dense as those of the hydrogen atom, thus providing some understanding of the role of the one-photon-exchange force relative to the (long-range) multiple-photon-exchange forces. The possibilities for extending the technique to the relativistic one-photon case and the question of electromagnetic corrections to the strong interactions are briefly discussed. Finally, some possible approaches to including higher order photon exchanges are considered. (auth)

34293 N-BODY RELATIVISTIC SCATTERING THEORY. Rosenberg, Leonard (New York Univ., N. Y.). Phys. Rev., 147: 1016-27(July 29, 1966).

A set of coupled linear integral equations is proposed as a means of generating Lorentz-invariant multiparticle scattering amplitudes which satisfy truncated unitarity relations. Steady-state nonrelativistic scattering theory, in particular the version based on the generalized Faddeev equations, is used as a guide in the formulation and physical interpretation of the equations. The input to the integral equations is a set of scattering amplitudes for subsystems of particles. Creation and annihilation processes are described by the interchange of terminal-state scattering amplitudes with vertex functions, in complete formal analogy with the nonrelativistic treatment of break-up and capture events. A wave function is introduced, a conserved current is defined, and a perturbation theory for discrete states is set up. Formulas for transition rates, for reaction and decay processes, are derived which agree with the familiar results of time-dependent Hamiltonian theory. The possibility that self-consistency criteria might provide a basis for the determination of the input amplitudes is noted. (auth)

34294 NONCOMPACT GROUPS IN ELEMENTARY-PARTICLE THEORY. Hillion, Pierre (Institut Henri Poincare, Paris). Phys. Rev., 147: 1038-44(July 29, 1966).

Groups leaving invariant a quadratic or Hermitian form are divided into four classes, and particles are associated with their finite irreducible representations. It is proved that the Wigner-Eckart theorem in its local form is a class theorem. Thus, the same relations between the expectation values of certain operators can be found for different groups. (auth)

34295 SYSTEMATIC STUDY OF THE BALAZS BOOTSTRAP METHOD. Bond, A. H. (Imperial Coll. of Science and Tech., London. Rutherford Lab., Chilton, Eng.). Phys. Rev., 147: 1058-70(July 29, 1966).

The Balázs approach to $\pi\pi$ scattering was systematically studied numerically. On increasing the number of poles representing the unphysical cut, the solution changes drastically and disappears. It is concluded that the single-channel calculations are so unstable as to be meaningless. It is proposed that such resonances as occur using the Balázs matching process to pole forms do so by accident for small numbers of poles and are not related to any exact solution. When several partial waves were included, it was very difficult to find solutions because of false minima; however, the P_1-D_0 calculation had at least two solutions. (auth)

34296 SEPARABLE TWO-BODY POTENTIALS FOR MULTIPARTICLE SCATTERING. Mongan, Thomas R.

(Univ. of California, Berkeley). Phys. Rev., 147: 1117-22(July 29, 1966). (UCRL-16614).

Separable potential forms which lead to on-energy-shell partial-wave transition amplitudes for two-body scattering which have analyticity properties very similar to those proved in local potential theory are studied. An explicitly energy-dependent potential form is shown numerically to give a better approximation to the amplitude from a local Yukawa potential than the best previous form, for $l > 0$ in the scattering region. Some remarks are made about the applicability of these potential forms to multiparticle scattering calculations. (auth)

34297 GETTING AN SU(6) RESULT FROM CHIRAL SU(3) x SU(3). Ryan, C. (Dublin Inst. for Advanced Studies). Phys. Rev., 147: 1139-41(July 29, 1966).

The recent discovery that the SU(6) relation for the axial vector current strength can be derived from the chiral SU(3) x SU(3) group is investigated more fully, and the reason for this result is explained. (auth)

34298 BROKEN SYMMETRY DENSITIES WITHIN A CURRENT ALGEBRA. Griffith, Richard W. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 147: 1141-4(July 29, 1966). (CALT-68-61).

An obvious characteristic of current-algebra symmetry is its brokenness. The role of quantities which are a manifestation of that breakage, such as the divergences of axial-vector currents, $D_i(x)$, is considered. It is relevant to investigate the commutation properties of these densities, and it is found that the $D_i(x)$ could commute with one another at equal times. The argument for this commuting property, involving a matrix element of time-derivative, axial-vector charges, contains the assumption of an unsubtracted dispersion relation. Should the densities $D_i(x)$ (or their space-integrated correspondences, the time derivatives of axial-vector charges) prove useful for multiplet building, the origin of possible manifestations in a particle spectrum of a noncompact group could lie in the brokenness of the compact symmetry. The hypothesis of no subtractions may provide a link between noncompactness of a particle spectrum and the bootstrap. (auth)

34299 ORDINARY AND GENERALIZED BETHE-SALPETER EQUATIONS IN THE UNEQUAL-MASS CASE. Nakanishi, Noboru (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 147: 1153-60(July 29, 1966). (BNL-9787).

The Bethe-Salpeter equation in the unequal-mass case is investigated in the Wick-Cutkosky model. It is emphasized that there are several qualitative differences between the equal-mass case and the unequal-mass case. The normalization properties of Bethe-Salpeter amplitudes are analyzed in detail. It is pointed out that the scattering Green's function has multiple poles at the energy which equals the mass difference of the two particles. The corresponding generalized Bethe-Salpeter amplitudes are discussed in connection with the ordinary ones. (auth)

34300 WEAK INTERACTIONS IN SU(6) AND $\tilde{U}(12)$. Pakvasa, S.; Rosen, S. P. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 147: 1166-73(July 29, 1966).

Weak interactions are studied in SU(6) and $\tilde{U}(12)$. The weak currents are assigned to the 35-dimensional representation of SU(6) [or the 143 in $\tilde{U}(12)$], and the predictions of a Cabibbo-type theory are derived. For nonleptonic decay, the 35 has been shown to be inconsistent with experiment, and so the effective Hamiltonian is assigned to an admixture of 35 and 405. This assignment is now consistent with experiment, and, when one extra assumption is made, it leads to the Lee-Sugawara triangle and the vanishing of $\langle \Sigma^+ | n\pi^+ \rangle$ for parity-violating amplitudes. In $\tilde{U}(12)$, the assignment 143 + 5940 yields the same results. Amplitudes for Ω^- decay modes are related to amplitudes of known decays, and the corresponding rates are calculated. (auth)

34301 POSSIBLE EXTERNAL AND INTERNAL MOTIONS OF ELEMENTARY PARTICLES ON RIEMANNIAN MANIFOLDS. Vigier, J. P. (Institut Henri Poincare, Paris). Phys. Rev. Lett., 17: 39-41(July 4, 1966).

A proposal is made in which elementary particles are extended structures within real physical space-time. The proposal includes the following assumptions: that external and internal motions of elementary particles are isometric groups of motions on different external and internal five dimensional curved Riemannian manifolds (Lichnerowicz's domains of isometry); and that these domains are connected through an isometry boundary (timelike hypertube) built with trajectories of the internal motions and geodetics of the external domain. (B.G.D.)

34302 ELECTROMAGNETIC MASS DIFFERENCES IN THE QUARK MODEL. Rubinstein, H. R. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 17: 41-3 (July 4, 1966).

It is shown that the quark model plus an extremely simple dynamical assumption are enough to give a remarkably good account of the electromagnetic mass differences of both baryons and mesons. (B.G.D.)

34303 INABILITY OF THE QUARK TO BOOTSTRAP. Nieto, Michael Martin (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 17: 43-5(July 4, 1966).

The results of an investigation of the possibility of bootstrapping the $3 \otimes 8 = 3 \oplus 6^* \oplus 15$ system, which is a triplet of baryons scattered from a pseudoscalar octet of mesons. (B.G.D.)

34304 ELECTROMAGNETIC CURRENT IN SL(6,C). Leutwyler, H. (Princeton Univ., N. J.). Phys. Rev. Lett., 17: 156-9(July 18, 1966).

A relativistic extention of SU(6) (Budini and Fronsdal, Phys. Rev. Letters 14: 968(1965)) which was previously applied to a simplified calculation of the electric-charge form factor of the baryons is discussed. In that calculation the electric charge was treated as an SL(6,C) scaler. As an alternative, an electromagnetic current obeying the next simplest transformation rules is considered. In analogy with the well known treatment in the framework of SU(6), the current is associated with certain components of a tensor operator which transforms like 70 generators of SL(6,C). (B.G.D.)

34305 MAXIMAL CHIRAL GROUP WITH THE QUARK MODEL. Okubo, S. (Univ. of Rochester, N. Y.); Marshak, R. E.; Goldberg, H.; Ryan, C. Physics, 2: 273-89(June 1966). (UR-875-120).

The use of the quark model as a probe of higher symmetry groups for hadrons, which generate the mass spectra as well as the algebra, is investigated. The maximum chiral group $\overline{W}_3 \otimes N_3$ is determined as the spectrum-generating group, which mixes spin and unitary spin in the mass spectra of hadrons. The current algebra suggested by the $\overline{W}_3 \otimes N_3$ group is derived. A complete tabulation of the various higher symmetry groups obtainable with the quark model is given in the appendix. (L.B.S.)

34306 ELECTRICITY IN THE INFINITELY SMALL. STRUCTURE OF MATTER: BARYONS, MESONS, AND STRONG INTERACTIONS. Astier, A. Rev. Gen. Elec., 75: 9-32(Jan. 1966). (In French).

After reviewing previous data and explaining the "superselection" law resulting from the conservation of baryonic and leptonic charges, the strong interaction particles known in 1954: baryons and mesons, are presented, and these strong interactions, characterized by "strangeness" conservation, are compared with the other kinds of interaction (gravitic, weak and electromagnetic). Then the concepts of unstable states, average life, mass indetermination (width) and resonance are presented. Following this, the "resonance" kind of baryons and mesons observed since 1954 are given and it is shown how these particles can be grouped. In conclusion, it is shown how, in order to advance the knowledge of matter, it is necessary to discover the adequate conceptual system and to enter into the field of sub-particular distances by means of accelerators of very high energy. (auth)

34307 ELEMENTARY PARTICLE SYMMETRIES. Bryden, A. D. (London Univ.). Sci. Progr. (London), 54: 243-56(Summer 1966).

Application of symmetry groups simplified classification of elementary particles. SU(2) and SU(3) symmetry schemes are well established and many of their predictions are in good agreement with experiment. A short review of these symmetry groups is mainly concerned with attempts to combine these symmetries with relativistic invariance, leading to the groups SU(6) and $\tilde{U}(12)$. Difficulties of interpretation and experimental predictions are briefly discussed. (auth)

34308 POLYNOMIAL BASES OF GROUP SU_3 AND AN EXPLICIT EXPRESSION FOR ITS CLEBSCH-GORDAN COEFFICIENTS. Hou, Pei-yu. Wu Li Hsueh Pao, 22: 460-70(Apr. 1966). (In Chinese).

A complete set of polynomial bases for representing the SU_n group is constructed using the properties of the Young diagrams. The basis of irreducible representations in the product space of two irreducible representations is discussed, and an explicit expression for the Clebsch-Gordon coefficients of the SU_3 group is obtained. (G.O.Y.)

34309 RELATIVISTIC SUPERMULTIPLET THEORY AND ITS CONNECTION WITH THE "HYBRID GROUPS." Rothleitner, J. (Univ., Heidelberg). Z. Phys., 194: 201-7 (1966).

The relativistic extension of Wigner's supermultiplet theory proposed by Budini and Fronsdal is discussed. It is shown that the predictions of this model are exactly the same as those emerging from the "hybrid group" of a previously discussed model. The model will give new relations, however. These will connect processes involving the lowest supermultiplets (the only ones studied so far) with processes involving higher supermultiplets. (auth)

34310 SOLUTION AND QUANTIZATION OF THE NONLINEAR TWO-DIMENSIONAL MODEL FOR A BORN-INFELD TYPE OF FIELD. Barbashov, B. M.; Chernikov, N. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 50: 1296-1308(May 1966). (In Russian).

The Cauchy problem is solved for the nonlinear equation for a scalar field of the Born–Infeld type. The solution is obtained in a parametric form. It is pointed out that the solution defines an extremal surface, in three dimensional pseudo-Euclidian space. A geometric interpretation of this type points to the possibility of solving a more complex problem, viz., that of several nonlinear interacting fields. The solution of the generalized model is geometrically interpreted as a two dimensional extremal surface in multidimensional pseudo-Euclidian space. In the solutions the time t and coordinate x along with the field functions φ_i are are interpreted as components of a new multicomponent field. On basis of this interpretation a procedure is developed for quantization of such nonlinear systems without applying perturbation theory. As a result of quantization the time t and coordinate x as well as the field wave function turn out to be operators. Consequently, a theory in quantized space-time arises. (auth)

34311 MODEL FOR BROKEN ISOTOPIC SYMMETRY IN A UNIFIED ELECTROMAGNETIC-WEAK HADRON INTERACTION. Lipmanov, E. M. (Volgograd Pedogogical Inst., USSR). Zh. Eksp. Teor. Fiz., 50: 1309-21(May 1966). (In Russian).

The possibility of constructing a model of a unified electromagnetic-weak hadron interaction possessing broken isotopic symmetry is studied. Vanishing of the photon mass and conservation of parity in electromagnetism are a consequence of violation of symmetry of the primary isotopically unified and CP invariant interaction which is due to mixing of vector bosons from different isotopic multiplets. The well known empirical selection rules for weak hadron interactions and their minimal electromagnetic interaction appear as specific manifestations of violated symmetry at low energies. An interesting effect of restoration of violated symmetry at high 4-momentum transfers derived in the e^2 approximation in perturbation theory is discussed. (auth)

34312 ANALYTICITY OF THE SCATTERING AMPLITUDE IN QUANTUM FIELD THEORY WHEN LOCAL COMMUTATIVITY IN WEAKENED TO A CONDITION OF EXPONENTIAL DECREASE. Dobson, Peter Norman Jr. College Park, Md., Univ. of Maryland, 1965. 57p. Thesis.

Fields having the property that every matrix element of the commutator of two field operators decreases exponentially with the separation distance R as the argument of one of the operators is displaced sufficiently far in a space-like direction are discussed. If the decrease with R is at least as fast as e^{-MR}, the field is called "quasi-causal of degree M." It is shown that quasi-causality is sufficient to imply that the truncated vacuum expectation values of the theory obey a space-like asymptotic condition. It follows, then, by the arguments of Hepp, that quasi-causal fields obey the asymptotic condition of Lehmann, Symanzik, and Zimmermann. The asymptotic condition is used to define an elastic scattering amplitude and relate it to the field quantities via reduction formulas. The quasi-causality condition then permits the application of the method of Bremermann, Oehme, and Taylor to continue analytically the scattering amplitude in the energy variable. The continuation is most conveniently carried out in the "brick-wall" reference frame, which is fixed by requiring that one particle have its final 3-momentum, Δ, equal and opposite to its initial 3-momentum. The energy of the other particle, ω, is the variable used for the analytic continuation. For fixed momentum transfers, it is related in a simple way to the usual invariant energy variable. It is found that the elastic scattering amplitude of a field that is quasi-causal of degree M in a theory of particles of mass m may be continued in the ω-plane into the region $D(\Delta^2) = \{\omega | (1m\omega/M)^2 < 1 - |\Delta^2 + m^2/M^2 + (Re\omega)^2|\}$ except for the usual cuts and poles on the real axis. This is true provided $M > m$ and $\Delta < \Delta_{MAX}$. (Dissertation Abstr. Abstr.)

34313 RECENT DEVELOPMENTS IN PARTICLE SYMMETRIES. 1965 International School of Physics "Ettore Majorana," a CERN-MPI-NATO Advanced Study Institute. Zichichi, A. (ed.). New York, Academic Press, 1966. 470p. $12.00.

An up-to-date account of the current research on the symmetry approach to particle physics is presented. Lectures are presented on theoretical problems such as CP invariance, relativistic formulation of unitary symmetry, SU_6, algebra of currents and symmetry breaking, and superconductivity. Lectures are also included on a number of associated experimental problems. Separate abstracts are prepared for each of the 14 lectures. (L.B.S.)

For abstracts of individual lectures see: 34240–34247, 34314–34318, and 34446.

34314 HIGHER SYMMETRIES. Pais, A. (Rockefeller Inst., New York). pp 13-46 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

A brief introduction to unitary symmetry defines the unitary group U(N), the special unitary group SU(N), and the pseudo-unitary group U(m,n). The problem of obtaining all irreducible representations of SU(N) is treated by the general method of Young. The group SU(6) with applications, SU(6,6) and subgroups, and the subgroup $SU(6)_w$ of SU(6,6) are treated. A number of exercises are included. (L.B.S.)

34315 DEVIATIONS FROM UNITARY SYMMETRY. Sharp, D. H. (Princeton Univ., N. J.). pp 47-103 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

A review is given of some of the experimental evidence of SU(3) violations, and how this leads to a pattern of universal octet enhancement. The general features of the bootstrap theory of deviations from unitary symmetry are outlined. An S-matrix method is discussed for calculating the change in position and residue of a bound-state pole resulting from a small change in the forces that produce the bound state. The techniques are applied in conjunction with a specific reciprocal bootstrap model for the baryon octet (B) and decuplet (Δ), to study the strong and electromagnetic mass shifts in the B and Δ supermultiplets and

the strong, electromagnetic, and weak shifts in the BBπ and BAπ couplings from their SU(3) symmetric values. The results are summarized. (L.B.S.)

34316 BROKEN SYMMETRIES AND SUM RULES. Cabibbo, N. (CERN, Geneva). pp 104-37 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

A brief discussion is given of exact symmetries. The possibility that a broken symmetry is a manifestation of an exact algebraic structure of certain operators, not all of which commute with the hamiltonian, is then discussed. A derivation of the Adler-Weisberger sum rule is presented. The saturation of commutation relations and particle multiplets is treated, and a possible algebra at local currents is illustrated. (L.B.S.)

34317 DIFFICULTIES OF RELATIVISTIC U(6). Bell, J. S. (CERN, Geneva). pp 138-75 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

The difficulties encountered in attempting to construct a theory that exactly incorporates both U(6) symmetry and Lorentz invariance are treated in terms of simple models, quarks, field operator, wave functions, and lagrangians. (L.B.S.)

34318 SIGNIFICANCE OF INTERNAL SYMMETRIES. Radicati, L. A. (Scuola Normale Superiore, Pisa, Italy). pp 275-87 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

The application of group theory to the study of internal symmetries and its significance for deducing selection rules and for classification of various interactions in elementary particle physics are discussed. Results that can be obtained from the well-ordered violation of internal symmetries are pointed out. The relation between internal and geometrical symmetries in Wigner's theory of nuclear supermultiplets is treated. (L.B.S.).)

34319 MATSCIENCE SYMPOSIA ON THEORETICAL PHYSICS. Volume 1. Lectures Presented at the 1963 First Anniversary Symposium of the Institute of Mathematical Sciences, Madras, India. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966. 180p. $9.50. (CONF-630102).

Separate abstracts were prepared for each of the twelve papers included. (G.O.Y.)

For abstracts of individual papers see: 34169–34176, and 34320–34323.

34320 SYMMETRIES AND RESONANCES. Radha, T. K. (Matscience, Madras). pp 1-28 of Matscience Symposia on Theoretical Physics. Vol. 1. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966.

The need for higher symmetries is considered. Charge conservation and charge independence from unitary groups is discussed along with resonances in models built on SU_3 with the Sakata model and on SU_3 with the octet model. Global symmetry and models built on other groups are also considered. Two $J = 5/2^+$ resonances are predicted, both from symmetry arguments and from the Regge trajectories. (G.O.Y.)

34321 GROUP SYMMETRIES WITH R INVARIANCE. Marshak, R. E. (Univ. of Rochester, N. Y.). pp 29-39 of Matscience Symposia on Theoretical Physics. Vol. 1. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966.

Some results obtained by combining SU(3) symmetry with R-invariance in several possible formulations are discussed. The SU(3) octet model is stressed, but the Sakata model and the global symmetry model are also briefly mentioned. Electromagnetic effects are considered as are some predictions of R or R′ invariance for particle resonances. (D.C.W.)

34322 REGGE POLES AND RESONANCES. Radha, T. K. (Matscience, Madras). pp 41-61 of Matscience Symposia on Theoretical Physics. Vol. 1. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966.

The theory of potential scattering and poles in the complex angular momentum plane is discussed along with the movement of the pole with energy and potential in this plane. The concept of Regge poles is then applied to the theory of elementary particles, and the theories of baryon and meson resonances are studied using the Gell-Mann factorization principle. The meson(ω) and meson(ρ) trajectories are studied in detail. A few theoretical developments in this field are also listed. (G.O.Y.)

34323 REGGE POLES IN PERTURBATION THEORY AND WEAK INTERACTIONS. Raman, K. (Matscience, Madras). pp 63-72 of Matscience Symposia on Theoretical Physics. Vol. 1. Ramakrishnan, Alladi (ed.). New York, Plenum Press, 1966.

The consequences of assuming that the Regge trajectory provides a generalization of the current-current interaction are investigated along with the use of Regge poles as an improved pole approximation in low-energy weak interactions. The relation of Regge trajectories to conserved currents and to composite-particle models is discussed. Regge poles from perturbation theory in weak interactions are also considered. (G.O.Y.)

34324 RELATIVISTIC ELEMENTARY INTERACTION MECHANICS AND ITS RELATIONSHIP TO QUANTUM MECHANICS. Leiter, D. (Boston Coll., Chestnut Hill, Mass.). 40p. (CONF-660107-19). ORAU. Gmelin, AED-CONF-65-003-28.

From American Physical Society Meeting, New York.

A new theory of elementary interactions is discussed and Maxwell's equations are re-interpreted within its context. A one particle quantum mechanical formalism is derived as a linear approximation to this nonlinear deterministic C-number elementary interaction-field theory. The modifications of quantum mechanical postulates and predictions which occur in the full theory are discussed, and a solution to the scattering interaction is developed. (auth)

34325 MAGNETIC MOMENT OF THE $3/2^+$ DECUPLET FROM THE ALGEBRA OF CURRENT COMPONENTS. Rajaraman, R. 6p. (CONF-660107-23). ORAU. Gmelin, AED-CONF-66-003-37.

From American Physical Society Meeting, New York.

It is shown that on using the U(6) × U(6) algebra of current components to determine the magnetic moments of the $3/2^+$ decuplet states, the SU(6) prediction of $\mu_{10} = Q\mu_p$ is not acquired. (B.G.D.)

Fluid Physics and Thermodynamics

See also Plasma Physics and Thermonuclear Processes

Refer also to abstracts 34065, 34405, and 34509.

34326 (AD-634521) A CRITICAL SURVEY OF MAGNETOFLUIDDYNAMICS. PART IV. MODERN ASPECTS OF MAGNETOFLUIDDYNAMICS (TENSOR ELECTRICAL CONDUCTIVITY AND MULTIFLUID THEORY). Pai, Shih-I (Maryland Univ., College Park). Mar. 1966. Contract AF33(657)-7805. 74p. (ARL-66-0060). CFSTI $3.00 cy, $0.75 mn.

A critical survey of modern aspects of magnetofluid dynamics (MFD) based on multifluid theory with special emphasis on new features different from the classical magnetofluid dynamics is presented. First the fundamental equations of multifluid theory of MFD are discussed and their effects on the electrical current density, the Hall current and ion slip are treated. Then many typical flow problems of MFD are examined with tensor electric conductivity or by multifluid theory, which include quasi-one dimensional flow, MFD channel flow, Rayleigh flow, linearized theory, wave motion, boundary layer flow, heat transfer problem, electrical characteristic of Langmuir type probe. These results are compared with those obtained by classical MFD single fluid theory with scalar electrical conductivity. (auth)

34327 (BNL-940, pp 16-22) LIQUIDS. Vineyard, G. H. (Brookhaven National Lab., Upton, N. Y.).

Current understanding of the atomic structure and atomic dynamics of simple liquids is reviewed. In the past decade the theory of transport coefficients and of scattering processes has been improved by the introduction of time-displaced correlation functions. Results are mainly formal, however, and specific calculations still depend on models, a great many of which have been proposed. Another major advance has come recently from computer "experiments" on classical fluids. The interrelation of these methods with neutron scattering will be discussed. (auth)

34328 (BNL-940, pp 155-8) A MODIFIED KINETIC MODEL FOR THE CALCULATION OF $G_s(r,t)$ IN DENSE FLUIDS. Gibbs, Alan G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A model is proposed for the calculation of Van Hove's $G_s(r,t)$ in a classical liquid. The motion of a typical atom is analyzed in terms of the dynamics of an "oscillation," a quasi-particle consisting of the atom plus a surrounding spherical shell representing the collective effect of the instantaneous near neighbors. This shell is assumed to create a harmonic potential well in which the atom oscillates, subject to stochastic forces, while the center of mass moves according to a recently proposed model in which oscillatory motion is neglected. Thus the previous work is generalized to include oscillatory effects, which are found to contribute significantly to $S_s(\kappa,\omega)$, the Fourier transform of $G_s(r,t)$, for intermediate values of κ. Comparison with Rahman's calculations for liquid argon shows good agreement for both $\langle r^2(t)\rangle$ and the non-Gaussian effects. Work is at present under way to provide a rigorous derivation of this model, based on the Liouville equation. (auth)

34329 (BNL-940, pp 183-90) A STATISTICAL EVALUATION OF ELASTIC SCATTERING DATA WITH APPLICATION TO THERMAL NEUTRON SCATTERING IN LIQUID ARGON. Schlup, Werner A. (Watson Scientific Computing Lab., New York).

The influence of the counting errors in neutron diffraction experiments on the pair-correlation and the potential following from the Percus-Yevick and the hyper-netted chain equations is discussed for the Henshaw data for liquid argon at 84°K. The results are shown to be very sensitive to the small-angle scattering and the choice of the coherent scattering ratio. The uncertainty in the derived pair potential is of the order of the potential depth. (auth)

34330 (N-66-10545) DIE BEHANDLUNG MAGNETOFLUIDODYNAMISCHER STROMUNGSVORGANGE IN THERMODYNAMISCHEN ZUSTANDSDIAGRAMMEN. (The Handling of Magnetohydrodynamic Circulation Procedures in Thermodynamic Equilibrium Diagrams). Lillich, Karl Heinz (Technische Hochschule, Stuttgart (West Germany)). 1964. 107p. CFSTI $4.00 cy, $0.75 mn.

Composition and thermodynamic phase values for the thermodynamic equilibrium states of various gases, as presented in enthalpy-entropy diagrams, were extended to include the magnetohydrodynamic flow conditions. Phase change values of the gas medium during magnetohydrodynamic flow were obtained with thermodynamic phase diagrams for the real state of the gas under consideration of the developed dissociation and ionization changes. Sample calculations for the enthalpy-entropy and enthalpy-density diagrams of a magnetohydrodynamic energy process are given. (STAR)

34331 (N-66-13027) THE EFFECT OF WALL CONDUCTANCE ON MAGNETOHYDRODYNAMIC FLOW THROUGH FINITE CROSS SECTION CHANNELS. Report Number 1. Gold, Richard R. (Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.). Nov. 1965. 30p. (SSD-50050R).

A detailed analysis of fully developed MHD flow through rectangular and circular channels is presented for nonzero finite values of the uniform wall conductance ϕ. In particular perturbation solutions are derived for small and large values of ϕ for the rectangular channel and small values of ϕ for the circular geometry. These results are combined with existing exact and approximate calculations in a semigraphical procedure to obtain the ratio of mean velocity to pressure gradient as a function of arbitrary values of Hartmann number and ϕ. Of particular interest is the substantial difference found between the present results when $\phi \ll 1$ and previous results for $\phi = 0$. (auth)

34332 (N-66-16250) ELECTRODE CURRENT DISTRIBUTIONS IN MGD CHANNELS. Hoffman, Myron A.; Oates, Gordon C. (Massachusetts Inst. of Tech., Cambridge. Center for Space Research). Jan. 1966. 45p. (NASA-CR-69996; CSR-TR-66-1). CFSTI $2.00 cy, $0.50 mn.

Experimental and theoretical investigations have been made of the current distributions to continuous and segmented electrodes in linear MGD channels. The electrodes were subdivided to obtain a measure of the current distribution for various average current densities up to 0.7 amps/cm^2 and Hall parameters up to 5. Current concentrations were measured at the edges of electrodes. However, the concentrations were less pronounced than those predicted by theories in which constant electrode potential and uniform gas properties are assumed. The experimental results are compared to the predictions of a semiempirical theory that includes a current density dependent electrode potential. The agreement between experiment and theory in this case is more satisfactory. It is concluded that electrode and sheath voltage drops tend to limit current concentrations on the electrodes at least in the current density and Hall parameter regime. (auth)

34333 (N-66-17261) RELATIVISTIC CHARGED FLUID FLOW. II. GENERALIZED LARMOR AND HELMHOLTZ THEOREMS. Schmid, Lawrence A. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct. 1965. 45p. (NASA-TM-X-55389; X-641-65-421). CFSTI $2.00 cy, $0.50 mn.

The covariant Larmor theorem is derived within the framework of special relativity for an inviscid charged fluid in the presence of an arbitrary electromagnetic field and a gravitational field which is described by a simple scalar potential. The flow need not be adiabatic and the fluid need not be barotropic. The covariant form of the Larmor theorem, which is an antisymmetric tensor equation, is equivalent to two 3-vector equations, one of which is the fluid equation of motion. The other is just the familiar 3-vector statement of the Larmor theorem except for an extra precession that is thermal in origin. The relativistic Helmholtz equation is derived for the covariant Larmor theorem. The vorticity is defined as the curl of the usual canonical momentum of a charged particle in an electromagnetic field except that the particle rest mass is a variable that includes contributions that are proportional to the gravitational potential and the specific enthalpy of the fluid. For this definition of the vorticity it is found that the vorticity flux diffuses through the fluid except when the flow is isentropic. It is shown, however, that when an appropriate thermal 4-potential is included in the definition of the canonical momentum, the vorticity flux remains frozen in the fluid even when viscosity is present and the flow is nonadiabatic. A microscopic interpretation of this generalized Helmholtz equation is given. (auth)

34334 MAGNETOHYDRODYNAMIC POTENTIAL FLOW OVER A CYLINDER WITH AN AXIAL MAGNETIC FIELD. Hughes, W. F. (Carnegie Inst. of Tech., Pittsburgh). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1104-5(June 1966).

Considering a two dimensional MHD flow at low magnetic Reynolds number of an inviscid, incompressible, conducting neutral fluid about an insulating cylinder with a uniform applied magnetic field, it is shown that the velocity distribution is exactly that of classical potential flow, but that the pressure distribution is different from classical potential flow and gives rise to a drag that is proportional to the interaction parameter. (B.G.D.)

34335 MODIFIED POHLHAUSEN VELOCITY PROFILE FOR MHD BOUNDARY-LAYER PROBLEMS. Heiser, William H.; Bornhorst, Walter J. (Massachusetts Inst. of Tech., Cambridge). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1139-41(June 1966).

A velocity profile is developed to handle both MHD and free-stream pressure gradient effects. The boundary-layer velocity profile examined was allowed to be a function of both the local Hartmann number and the local dimensionless free-stream pressure gradient based upon the local boundary-layer thickness by applying a modified Pohlhausen method. (B.G.D.)

34336 RELAXATION IN A DISCRETE SPECTRUM IN THE INSTANTANEOUS-COLLISION APPROXIMATION. Burshtein, A. I. (Inst. of Chemical Kinetics and Combustion, Academy of Sciences, Siberian SSR). Dokl. Akad. Nauk SSSR, 166: 577-9(Jan. 21, 1966). (In Russian).

A kinetic equation is derived for the density matrix of a system comprising a gas molecule or atom subject to the simultaneous action of fields and collisions, under the only condition that the collision time is much shorter than the time of the mean free path. A method is then presented for determining the parameters of the relaxation and the frequency shifts that appear in the equation, with and without allowance for the reaction of the particle that participates in the collision. An operator is introduced to describe the instantaneous transformation of the density matrix effected during the short collision time. Although the motion of the colliding atoms is described classically, the electronic states can be quantized with and without allowance for recoil. The kinetic equation is independent whether the collision is produced by a strong or weak interaction. (ATD)

34337 SHOCK COMPRESSION OF LIQUID HYDROGEN. Van Thiel, M.; Alder, B. J. (Univ. of California, Livermore). Mol. Phys., 10: 427-35(1966). (UCRL-7833-T(Rev.1)).

High explosives were used to shock liquid hydrogen to 39,500 bars, 5.2 cm^3/g and an estimated temperature of 1100°K from an initial state near the normal boiling point, 20.5°K and 14.1 cm^3/g. How far the melting curve and the equation of state can be pursued by shock wave experiments is discussed. The derived intermolecular potential between two hydrogen molecules is shown to be inadequately represented by the previously postulated Lennard-Jones 6-12 potential in the repulsive region between 2.0 and 2.7 Å. The power of the inverse intermolecular distance is shown instead to be 8.5 in that region if a purely repulsive potential is used. (auth)

34338 EVALUATION OF GAS FILLINGS IN DISCHARGE DEVICES BY H-F IGNITION VOLTAGE MEASUREMENTS. Arndt, R.; Hinzpeter, G. (Institut fuer Gasentladungsphysik, Griefswald, Ger.). Monatsber. Deut. Akad. Wiss. Berlin, 7: 702-7(1965). (In German).

The comparison of the measurement values showed that with the device such as that used in pure argon at several torr the filling pressure can be controlled to approximately ±0.1 torr. Hg partial pressures between 2×10^{-6} and 10^{-3} torr can also be measured in this region. If the gas pressure and Hg density are maintained constant, molecular gas additions can be determined when their partial pressure is $\geq 10^{-3}$ torr. Falsifications of the measurement values by recoil of the discharges on the gas are only to be expected in O_2 and air. (tr-auth)

34339 MEISSNER EFFECT IN A CLASSICAL ELECTRON GAS. Pfleiderer, J. (Univ., Bonn). Nature, 210: 614(May 7, 1966).

It is shown that van Leeuwen's theorem does not explain how a magnetic field can enter an electron gas without the assumption of surface friction. (B.G.D.)

34340 TRANSITIONS THROUGH TWO SUCCESSIVE OBLIQUE HYDROMAGNETIC SHOCKS. Ram, Rishi; Mishra, R. S. (Univ. of Allahabad, India). Nuovo Cimento (10), 43B: 236-49(June 11, 1966).

If two (or more) successive shock waves takes a gas from state 1 to state 2 and from there to state 3, the transition of flow from state 1 to state 3 cannot, in general, be effected by the passage of only one shock wave (L. D. Landau and E. M. Lifshitz: Fluid Mechanics (London, 1959)). The necessary and sufficient condition under which the transition of flow from state 1 to state 3 in steady flows of conducting gases can be effected by the passage of a single magneto-gas-dynamic shock is discussed. Furthermore, the condition is obtained under which the streamline, which passes through two successive oblique hydromagnetic shocks at a point P, will remain unaffected if the transition of flow from state 1 to state 3 is effected by the passage of a single oblique hydromagnetic shock. (auth)

34341 SYMMETRIC FLOW OF A CONDUCTING GAS FOLLOWING A NORMAL SHOCK OF VARIABLE STRENGTH. Verma, B. G. (Univ. of Gorakhpur, India). Nuovo Cimento (10), 43B: 307-15(June 11, 1966).

A study of nonhomentropic, spherical, cylindrical and one-dimensional unsteady flow of a perfectly conducting gas was made by taking Lagrange's equations of motion. An exact solution is obtained which may be applied to a shock moving into a region where the pressure is constant but the density varies according to a simple power law. (auth)

34342 CHARGED BOSE GAS. Chow, W. S. (Case Inst. of Tech., Cleveland); Lo, S. C.; Wong, K. W. Nuovo Cimento (10), 43B: 316-37(June 11, 1966).

The method of Bohm and Pines is adopted for the study of the ground-state energy as well as of the elementary excitations of a charged Bose gas. The ground-state energy thus obtained agrees with that of Girardeau. Based on the Bohm-Pines method and the Bogoliubov approximation, a detailed study of the interaction between particles and plasmons is carried out by making use of the linked-cluster method. The perturbation terms thus handled can be summed to infinite order. With the consideration of interaction, the ground-state energy of the system is corrected, though the correction is found to be negligibly small, and both the single-particle excitation spectrum and the plasmon excitation spectrum are obtained. The single-particle excitation spectrum is found to possess an energy gap, though different from that obtained by Foldy, and thus the system possesses the property of superconductivity. It is noticed that the Bogoliubov approximation adopted by Foldy and Girardeau is correct to the lowest order of the approximation. The energy gap in the single-particle excitation spectrum is found to be due to the long-range particle-plasmon interaction. (auth)

34343 ACCURATE MEASUREMENTS OF STRUCTURE FACTORS OF LIQUIDS BY SLOW-NEUTRON SPECTROMETRY. Ascarelli, P.; Caglioti, G. (CNEN, Ispra, Italy). Nuovo Cimento (10), 43B: 375-88(June 11, 1966).

With reference to the limits of validity of the static approximation, the use of the methods of conventional and quasi-elastic diffraction of slow neutrons for an accurate determination of the structure factor of liquids is discussed. Some criteria are suggested, which should be useful for extracting from a diffraction pattern the structure factor. Experimental tests supporting our remarks are also presented. (auth)

34344 BOSE-EINSTEIN CONDENSATION IN A LATTICE GAS. Bocchieri, P.; Seneci, F. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Nuovo Cimento (10), 43B: 392-5(June 11, 1966).

It is shown that the wave function of the ground state of a lattice gas exhibits a Bose-Einstein condensation at low particle density. (B.G.D.)

34345 CONCEPT OF TEMPERATURE IN STATISTICAL THERMODYNAMICS. Arzelies, H.; Lanlignel, A. (Univ. de Rabat, Morrocco). Nuovo Cimento (10), 44A: 270-1 (July 1, 1966). (In French).

It was hypothesized previously that, for Fermi and Bose gases, the Carnot (or absolute) temperature T and the distribution temperature τ, appearing in the exponents of the expressions for the Fermi and Bose distributions, are different. The fact that the inverse of τ, as well as the inverse of θ, the kinetic temperature, is an integrating factor of dQ

(the quantity of heat absorbed by the system during a reversible transformation) was overlooked in the previous work. If this fact is taken into account, the identity of T and τ can be obtained for certain conditions on T and τ, for perfect gases. The conclusions of the previous article on the relativistic transformations of Q and T remain valid. (M.J.T.)

34346 SINGLE-BEAM MEASUREMENT OF BOSE-EINSTEIN FLUCTUATIONS IN A NATURAL GAUSSIAN RADIATION FIELD. Alkemade, C. Th. J.; Bolwijn, P. T.; van der Veer, J. H. C. (State Univ., Utrecht). Phys. Lett., 22: 70-2 (July 15, 1966).

Excess noise caused by Bose-Einstein fluctuations in the radiation from the anode of a carbon-arc was detected in the photo current of a cooled InSb photodiode. Its dependence on several parameters was found to agree with our theory. (auth)

34347 AN EXACT ANALYSIS OF LAMINAR MAGNETOHYDRODYNAMIC FLOW IN THE ENTRANCE REGION OF A FLAT DUCT. Manohar, R. (Univ. of Saskatchewan, Saskatoon, Can.). Contract DA-11-022-ORD-2059. Z. Angew. Math. Mech., 46: 111-17 (Mar. 1966).

A numerical method for obtaining solutions of laminar boundary layer equations for incompressible fluids due to Hartree is modified to obtain solutions of the problem of laminar flow of a conducting fluid with constant properties in the entrance region of a semi-infinite flat duct with a transverse magnetic field. The nonlinear equations governing the flow in the entrance region are solved numerically for various values of Hartmann numbers and the corresponding velocity profiles, pressure distribution and inlet length are obtained. The same method can be applied to other problems of similar nature. (auth)

34348 THERMODYNAMICS OF LINEAR SPIN CHAINS IN A TRANSVERSE MAGNETIC FIELD. Pikin, S. A.; Tsukernik, V. M. Zh. Eksp. Teor. Fiz., 50: 1377-80 (May 1966). (In Russian).

A one-dimensional system of spins ($s = \frac{1}{2}$) with a strongly anisotropic interaction of the immediate neighbors is considered; the system is assumed to be in a homogeneous magnetic field directed along a given direction. Exact formulas are obtained for the thermodynamic characteristics of the system. It is shown that at $T = 0$ and a certain value of the magnetic field strength H_0 the magnetic susceptibility possesses a singularity of a logarithmic or root nature. The character of the singularity as well as the field strength H_0 depends on the relation between the interaction constants. (auth)

34349 VVEDENIE V DINAMIKU RAZREZHENNOGO GAZA. (Introduction to Dynamics of Rarefied Gases). Shidlovskii, V. P. Moscow, Izdatel'stvo Nauka, 1965. 218p.

Elements of the kinetic theory of gases are surveyed. The dynamics of flow of strongly and weakly rarefied gases is considered, including free-molecular flow, thermal diffusion, gas flow in pipes, drag, heat exchange, Couette flow, and streamline flow around disks. The problems of the structure of shock waves, gas flow between coaxial cylinders, and the pulsed motion of an infinite disk in a gas are discussed. The dynamics of a rarefied plasma is examined, with consideration of the kinetic equations, plasma oscillations, and plasma Couette flow. (M.J.T.)

34350 FLUID DYNAMICS TRANSACTIONS. Volume 2. [Proceedings of the 6th Symposium, Zakopane, Poland, September 2–9, 1963]. Fiszdon, W. New York, Pergamon Press, 1965. 652p. $18.50. (CONF-630915).

The conference included 46 papers. Separate abstracts were prepared for 3 papers. Topics covered by the remaining papers include mathematical methods, hypersonic flow, rarefied gas dynamics, magnetohydrodynamics, and gas dynamics. (J.F.P.)

For abstracts of individual papers see: 34351, 34352, and 34732.

34351 CLASSES OF NONSTATIONARY AXIALLY SYMMETRIC FLOWS IN MAGNETOGASDYNAMICS. Apanasewicz, S. pp 359-68 of Fluid Dynamics Transactions. Vol. 2. New York, Pergamon Press, 1965.

Axially symmetric flows in magnetogasdynamics are classified from the viewpoint of configuration of electromagnetic fields in which the motion takes place. Five different classes are discerned, and their properties are discussed. (J.F.P.)

34352 REMARKS CONCERNING A DISSIPATIVE MODEL OF MAGNETOGASDYNAMICS. Bochenek, K. pp 405-10 of Fluid Dynamics Transactions. Vol. 2. New York, Pergamon Press, 1965.

A particular steady shock wave is considered taking into account all components of the field. This results in the appearance of different kinds of shock waves and characteristic roots corresponding to singular points. (J.F.P.)

Geophysics

34353 (N-65-34401) EXPERIMENTS ON EXPLORER XV. STUDY ON THE ENHANCED RADIATION BELTS. Project SERB. Final Report. (Bell Telephone Labs., Inc., New York). June 30, 1964. Contract NAS5-3058. 159p. (NASA-CR-67106). CFSTI $5.00 cy, $1.00 mn.

The energetic particles in the trapped radiation belts were studied, with particular emphasis on the electrons artificially introduced by high altitude nuclear explosions. Radiation damage to solar cells caused by particle exposure of Explorer XV in its orbit was also investigated. The fabrication, testing, and calibration of instrumentation for particle measurements, and the design, fabrication, and testing of solar cell damage detectors are described. Circuit schematics, assembly drawings, cross sections, module layouts, and photographs amplify the text. Data reduction and analyses results are plotted for several time intervals and satellite passes, and for the radiation damage rates observed in the experiment. (STAR)

34354 (N-66-11230) LOW-ENERGY ELECTRONS IN THE MAGNETOSPHERE. Serlemitsos, Peter (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Sept. 1965. 112p. (NASA-TM-X-55335; X-611-65-378). CFSTI $4.00 cy, $0.75 mn.

Thesis. Submitted to Maryland Univ., College Park.

A number of observations on satellite data which pertain to low-energy (≈100 kev) electrons in the earth's magnetosphere, and which were obtained with detectors aboard the scientific satellites Explorers XII and XIV are presented. These data cover essentially all low-latitude regions in the magnetosphere, between about 4.5 and 16 Re. In connection with the sunward side, the temporal and spatial characteristics of the observed outer boundary of the trapping region are investigated and observations were compared with other relevant information and with theoretical considerations. With regard to the dark side of the magnetosphere, information concerning the extent and the nature of the trapping region is discussed. In addition, the electron fluxes which appear outside the trapping region are studied with regard to certain temporal and spatial features, such as anisotropies, radial dependence and dependence on magnetic latitude. The results of this investigation are discussed, with emphasis on the new findings and their possible interpretations. (auth)

34355 (N-66-14637) THE GENERATION OF ELECTRON CYCLOTRON WAVES IN THE MAGNETOSPHERE AND THE TURBULENCE DIFFUSION OF OUTER-BELT ELECTRONS. Miller, Richard I. (California Univ., Berkeley. Space Sciences Lab.). Aug. 20, 1965. 136p. (NASA-CR-69004). CFSTI $4.00 cy, $1.00 mn.

The velocity distribution of energetic electrons trapped on geomagnetic field lines in the magnetosphere is found to be unstable with respect to the generation of electron cyclotron (whistler mode) waves. The growth of these waves results from the excess of transverse over parallel energy inherent in any loss cone type of velocity distribution. As a result, a spectrum of electromagnetic electron cyclotron wave turbulence is set up in the magnetosphere. This turbulence field then reacts on the electrons to diffuse

them in pitch angle, resulting in the scattering of electrons into the atmospheric loss cone and their precipitation from the outer radiation belt. A Fokker-Planck type of diffusion equation is set up to describe this scattering process and the pitch angle distributions it predicts are in agreement with satellite observations. The low level electron precipitation background is found to require a root mean square turbulence field of magnitude $4.0 \times 10^{-3} (6/L)^{3.5}$ gamma at the geomagnetic equator, while the frequent but short lived precipitation bursts require a momentary order of magnitude increase in this turbulence field strength. It is proposed that the pitch angle diffusion resulting from electron cyclotron turbulence is the dominant electron scattering mechanism in the outer radiation belt and determines trapped electron precipitation rates and lifetimes. (auth)

34356 (N-66-16385) THE DEVELOPMENT OF THE FORBUSH DECREASE AND THE GEOMAGNETIC STORM FIELDS. Yoshida, S.; Akasofu, S.-I. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). Dec. 1965. 28p. (NASA-CR-69871). CFSTI $2.00 cy, $0.50 mn.

Relations between the development of Forbush decreases and characteristics of associated geomagnetic storm fields are examined. It is shown that the onset of a significant Forbush decrease is more closely related to the development of successive sudden impulses or world-wide geomagnetic micropulsations during geomagnetic storms than to a simple step function-like storm sudden commencement. The magnitude of the main phase decrease shows no obvious relation with the magnitude of the Forbush decrease. (auth)

34357 (N-66-16393) THE AURORAL OVAL, THE AURORAL SUBSTORM, AND THEIR RELATIONS WITH THE INTERNAL STRUCTURE OF THE MAGNETOSPHERE. Akasofu, Syun-Ichi (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). Nov. 1965. 49p. (NASA-CR-69872). CFSTI $2.00 cy, $0.50 mn.

If the neutral sheet is the source region of auroral particles, they flow from the neutral sheet towards the earth and produce an oval-shape glow on the polar ionosphere, which is identified as the auroral oval. The auroral oval shows two major changes during geomagnetic storms; the expansion of the oval as a whole (the equatorward shift), and transient and repeated expansions and subsequent contractions of width, particularly in the midnight sector (the auroral substorm). The equatorward shift can reasonably be explained by the change of the internal structure of the magnetosphere resulting from the growth of the ring current and the neutral sheet current, and the interaction of these two systems. An attempt is made to explain the auroral substorm as a manifestation of imbalance of the two systems. The conservation of angular momentum suggests that the hot plasma flowing toward the ionosphere acquires a greater eastward speed than that of the earth's rotation. The interaction between this flow and the neutral atmosphere generates the polar electrojet. (auth)

34358 (N-66-16697) FURTHER REMARKS ON THE ABSENCE OF A VERY EXTENDED MAGNETOSPHERIC TAIL. Van Allen, J. A. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). [1965]. Contracts NAS7-100; JPL-950613. 24p. (NASA-CR-70047). CFSTI $1.00 cy, $0.50 mn.

For Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

Data from the Mars-bound spacecraft Mariner 4 are used to give answers to the following questions: to what antisolar distance in the earth's magnetospheric tail are there detectable intensities of super-thermal electrons; is the vector magnetic field due to the tail observable in the presence of the interplanetary magnetic field of the solar wind, the latter being the physical agent for the production of the tail; is the arrival of low energy (≤5 Mev) solar protons at the top of earth's atmosphere during the early phase of a PCA event preferentially in the auroral zones (geomagnetic latitude ~68°) and not within the polar caps; and does the effective geomagnetic cut-off for solar protons vanish at the same latitude for all energies less than ~40 Mev and with a sharpness in latitude corresponding to a gyro-radius. (STAR)

34359 (N-66-16975) SOME GENERAL ASPECTS OF GEOMAGNETICALLY TRAPPED RADIATION. Van Allen, J. A. (State Univ. of Iowa, Iowa City). Jan. 1966. 34p. (NASA-CR-70185). CFSTI $2.00 cy, $0.50 mn.

A sketch of the physical principles of radiation belts and an abridged summary of the present state of knowledge of the geomagnetically trapped radiation is presented. (B.G.D.)

34360 (N-66-17230) MOTION OF TRAPPED PARTICLES IN A DISTORTED FIELD. Mead, Gilbert D. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct. 1965. 25p. (NASA-TM-X-55391; X-640-65-434). CFSTI $1.00 cy, $0.50 mn.

The motion of charged particles in a geomagnetic field distorted by the solar wind is examined, using adiabatic theory. It is shown that the drift motion of particles trapped on high L-shells depends strongly on their equatorial pitch angle. Those mirroring near the equator move in on the night side, while those mirroring at low altitudes move out, thus producing a significant splitting of the L-shell with pitch angle. One consequence is that the very high latitude lines on the day side may contain trapped particles near the equator, but none near the ends of the lines. The opening up of field lines in the geomagnetic tail may be the controlling factor governing the high-latitude limit of trapping on both the day side and the night side. (auth)

34361 (N-66-17233) PARTICLE TRAJECTORIES IN MODEL CURRENT SHEETS. 2. ANALYTICAL AND NUMERICAL APPLICATIONS TO AURORAS USING A GEOMAGNETIC TAIL MODEL. Speiser, T. W. (National Aeronautics and Space Administration, Md. Goddard Space Flight Center). Nov. 1965. 52p. (NASA-TM-X-55395; X-641-65-451). CFSTI $3.00 cy, $0.50 mn.

Individual particle trajectories are solved for three models of possible field configurations of the geomagnetic tail. Two models contain magnetic field lines oppositely directed on either side of a neutral sheet, with an electric field perpendicular to the magnetic field and parallel to the neutral sheet. The models differ in the rate of variation of a magnetic field component perpendicular to the neutral sheet. For the two models, particles are accelerated and turned toward the earth within the neutral sheet and are ejected from the neutral sheet with small pitch angles to a magnetic line of force, with energies of tens-of-kilovolts. For the first model, a dipole-plus-tail model, electrons are ejected at about 150 R_e and protons about 50 R_e back in the tail. For the second model, an extended-tail-model, electrons are ejected at about 500 R_e, and protons at about 400 R_e. The third model consists of a three-dimensional dipole field added to a tail/neutral-sheet field. (auth)

34362 (N-66-17243) PLASMA PRESSURES IN THE MAGNETOSPHERE. Wakada, M. P. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1965. 22p. (NASA-TM-X-55411; X-641-65-507). CFSTI $1.00 cy, $0.50 mn.

By using a model that has the solar wind as the source for protons in the outer radiation belt, plasma energy densities near the equatorial magnetopause were estimated to be comparable to the magnetic field energy density there. The inflation of the geomagnetic field due to the presence of this plasma is discussed. The presence of high energy density plasma near the magnetic equator in the tail suggests that closed field lines exist at times out to 17 earth radii. (auth)

34363 (N-66-17248) SOURCE OF OUTER-ZONE PROTONS. Hess, W. N. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Sept. 1965. 37p. (NASA-TM-X-55375; X-640-65-389). CFSTI $2.00 cy, $0.50 mn.

Experimental proton flux and spectral data in the L = 2 to 5 range in the outer radiation belt were inspected. The equatorial pitch angle α_0 considered is near 90°. Changes in both the energy and equatorial pitch angle are calculated for cases where the first and second adiabatic invariants of the trapped particles are maintained during motion in L space. The way the flux of particles varies with motion in

the L region is also calculated. Reasonable agreement was found between measured fluxes and transformed fluxes for equatorial particles. In addition, off-equator particles having $\alpha_0 \neq 90°$ were also examined. Inspection of the transformed flux curves indicates that near the equator the agreement of the measured fluxes and transformed fluxes is quite good where direct comparison can be made, going off-equator up to proton energies of a few Mev. For higher energies, the region of agreement is quite small; and for locations well off-equator there is a decided discrepancy between the measured fluxes and transformed fluxes. The measured fluxes are consistently higher. Other particle experiments are also discussed. (STAR)

34364 (N-66-17252) MODELS OF THE EARTH'S MAGNETIC FIELD. Cain, Joseph C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct. 1, 1965. 35p. (NASA-TM-X-55379; X-612-65-400). CFSTI $2.00 cy, $0.50 mn.

Four mathematical models of the earth's magnetic field were constructed from currently available magnetic survey data obtained from magnetometers placed on land and towed behind ships and aircraft. The data are varied. Four separate magnetic field forces are defined: the core field; the crustal field; ionospheric currents; and plasma pressures. Most of the discussion and the field plots are confined to the core field (the main field from the molten core of the earth). The technique by which the core field is analyzed and characteristics of the four core field models are discussed. Comparison of the field models indicate that the method of fitting the measured data themselves instead of reading the data directly from magnetic charts is a useful approach and produces fields whose errors in regions of good data coverage are only a fraction of those previously obtained. As more data become available, the models should improve even further. (STAR)

34365 (N-66-17257) MAGNETOPLASMA DIFFUSION AT F2 REGION ALTITUDES. Kendall, P. C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct. 1965. 21p. (NASA-TM-X-55384; X-615-65-409). CFSTI $1.00 cy, $0.50 mn.

The magnetoplasma diffusion equation of the F2 region of the ionosphere is derived in its primitive form, allowing for electric currents flowing between conjugate points of the dynamo region and for temperature variations. It appears that the standard view of the ambipolar diffusion problem is correct. The ion-electron pairs may be thought of as sliding down the magnetic field lines with diffusive motion, while the whole field line drifts at right angles to itself. The electric current along a field line would affect the ionization only if its magnitude were 100 times greater than Dougherty's estimate of 10^{-7} amps/m^2. (auth)

34366 DIURNAL ENERGY VARIATION OF AURORAL X-RAYS. Bewersdorff, A. (Laboratoire de Physique Cosmique, Meudon, France); Dion, J.; Kremser, G.; Keppler, E.; Legrand, J. P.; Riedler, W. Ann. Geophys., 22: 23-30(1966).

The results presented were obtained during numerous balloon flights in the auroral zone. Two types of detectors were used: The standard instrument (Sparmo type) contained a telescope arrangement composed of three G-M counters, open towards the zenith; and an omnidirectional NaI(Tl) scintillation counter providing pulse height discrimination at three levels corresponding to energy losses greater than 20, 40, and 100 kev. The balloon flights were performed at Kiruna in Northern Sweden (geomagnetic latitude 65.3°N) during July, August, and September of 1963 and 1964. Results demonstrated that the average energy spectrum of auroral x rays in the range 20 to 150 kev undergoes marked diurnal variation. The steepest spectra were observed just after local midnight. The influence of absorption in the atmosphere on this result is estimated, and it is shown that the variation is caused principally by a similar diurnal variation of the energy spectrum of the primary auroral electrons. A relation seemed to exist between the steepness of the spectrum and the appearance of rapid fluctuations in the intensity. These results are supported by other findings from different methods for investigation of the energy of auroral electrons. (BBB)

34367 TEMPORAL VARIATIONS OF OUTER RADIATION ZONE ELECTRON INTENSITIES AT 1000 km. McDiarmid, I. B.; Burrows, J. R. (NRC, Ottawa). Can. J. Phys., 44: 1361-79(July 1966). (NRC-8991).

The intensities of electrons in the outer Van Allen radiation zone are examined as a function of time using particle detectors on the Alouette 1 satellite. The study covers the period December 1962 to May 1963, during which several moderately large magnetic storms occurred. It is shown that within a few hours after the onset of a magnetic storm the intensity of electrons above 40 kev increases consistently, while the intensity of electrons above 3.9 Mev may decrease and remain low for about a day, or it may remain at prestorm levels for about a day, after which an increase in intensity usually follows. During magnetically quiet periods, electron intensities decay with time constants τ which depend on the particle energy. Typical values of τ are as follows: electrons $E > 40$ kev at $L \sim 6$, $\tau = 4 \pm 1$ days; $E > 250$ kev at $L \sim 4.7$, $\tau = 6 \pm 2$ days; $E > 3.9$ Mev at $L \sim 4.3$, $\tau = 14 \pm 2$ days. Some of the measurements are compared with Explorer 14 measurements which were made at the same time, and significant differences are observed in the behavior of energetic electrons on the same L shells at 1000 km and near the equatorial plane. For electrons above 40 kev an attempt is made first to relate intensity increases at times of magnetic disturbances to an influx of particles from the "tail" of the magnetosphere and secondly to relate the intensity decreases at magnetically quiet times to a loss of particles into the atmosphere. (auth)

34368 POSSIBILITY OF USING GEOMAGNETIC STORMS FOR STUDY OF ELECTRICAL CHARACTERISTICS OF THE EARTH. Gokhberg, M. B. (Shmidt Inst. of Physics of the Earth, Academy of Sciences, SSSR). Dokl. Akad. Nauk SSSR, 166: 851-3(Feb. 1, 1966). (In Russian).

The application of an analytical method developed by Gorkhberg (1963) to the evaluation of electric characteristics of the earth is described, using data obtained from a strong transient electromagnetic disturbance recorded in the Ashkhabad area (4 December 1962). The evaluation is based on the transformation of an integral $F(p) = \int_0^\infty f(t)e^{-pt}dt$, and the computation of an expression $\rho_p = (0,4\pi/p)[E_y(p)/H_x(p)]^2$, where p is a real number with a frequency dimension, f(t) is the electric or magnetic field as a function of time, H_x is the horizontal component of the magnetic field, E_y is the horizontal component of the electric field, and ρ_p is the cross sectional resistance. It is shown that 1) a single electromagnetic process gives practically a complete curve of depth probing; 2) it may be assumed for pulses that usually occur, that $p \gtrsim 4/\tau$, where τ is the period; 3) the method of plane waves, (where the sphericity of the earth is neglected) can be used for a wide range of p values; and 4) spectra of the initial phases of magnetic storms be more frequently used in magnetotelluric studies. (ATD)

34369 THE BEHAVIOR OF THE D-REGION AT MIDLATITUDES DURING A SUDDEN IONOSPHERIC DISTURBANCE. May, B. R. (Radio and Space Research Station, Ditton Park, Eng.). J. Atmos. Terrest. Phys., 28: 553-64(June-July 1966).

The full-wave integration technique is used to deduce, from observations of the propagation of l-f and v-l-f radio waves, the changes which take place in the height distribution of electron density during a sudden ionospheric disturbance. Two SID's were studied, the first is an average SID which gives rise to most of the observed characteristics of the propagation of the radio waves and the second is an SID which occurred on 7 October 1948, during which continuous measurements were made of the strength and phase of downcoming waves at 16 and 70 kc/s at steep incidence. During the latter SID the electron density increased at all heights from 65 to 80 km by factors of 1.2, 2.4, 5.8, and 4.0 at heights of 65, 70, 75, and 80 km respectively. (auth)

34370 THE ONSET OF THE F-REGION DISTURBANCE AT MIDDLE LATITUDES DURING MAGNETIC STORMS. Thomas, L.; Venables, F. H. (Radio and Space Research

Station, Ditton Park, Eng.). J. Atmos. Terrest. Phys., 28: 599-605(June-July 1966).

A study was made of the initial disturbances in the peak electron density of the F2-region, N_mF2, at middle latitude stations during magnetic storms which begin with sudden commencements. It is shown that the major disturbances are associated with the onset of the main phase of the magnetic storm and not with the SC. The start and initial form of the ionospheric disturbance at any station is governed by the local time of the onset of the main phase; when this occurs during nighttime an immediate depression of N_mF2 occurs; when it occurs during daytime there is either an increase or no change in N_mF2 followed by a decrease during the evening. (auth)

34371 DYNAMICS OF THE AURORA. VII. EQUATORWARD MOTIONS AND THE MULTIPLICITY OF AURORAL ARCS. Akasofu, S.-I.; Kimball, D. S.; Meng, C.-I. (Univ. of Alaska, College). J. Atmos. Terrest. Phys., 28: 627-35(June-July 1966).

Equatorward motions of auroras are described in detail as follows: the equatorward shift associated with the earth's rotation; the equatorward motion during the recovery phase of the auroral substorm; and the equatorward spread of irregular bands during the substorm. The multiplicity of arcs associated with the equatorward motion is also described. (auth)

34372 ON THE TIME-LAG BETWEEN FLARE AND SEA MAXIMA. Reid, John H. (Sacramento Peak Observatory, Sunspot, N. Mex.). J. Atmos. Terrest. Phys., 28: 677-9(June-July 1966).

A comparison is made of the Edinburgh and Ondrejov Sudden Enhancement of Atmospherics (SEA) records to determine the time lag between flares and SEA. (B.G.D.)

34373 GENERAL RELATION BETWEEN THE ENERGY OF TRAPPED PARTICLES AND THE DISTURBANCE FIELD NEAR THE EARTH. Sckopke, Norbert (Univ. of Chicago). J. Geophys. Res., 71: 3125-30 (July 1, 1966).

The disturbance field caused by charged particles trapped in the earth's magnetosphere is fairly uniform near the earth. Its value at the earth's center, $\Delta H_z(0)$, which can be calculated easily, is therefore a good approximation for the field at the surface. Several years ago, Dessler and Parker derived for two special pitch-angle distributions of particles the simple relation $\Delta H_z(0)/H_0 = -2E/3E_m$ between $\Delta H_z(0)$ and the total energy of the particles, E. (H_0 and E_m are constants denoting the horizontal component of the main field at the earth's equator and the total energy of the main field external to the earth, respectively.) It is shown that this relation is applicable for any steady configuration of trapped particles, regardless of their pitch-angle distribution. (auth)

34374 CORRELATION OF PLASMA SCALE HEIGHT WITH K_p IN THE TOPSIDE IONOSPHERE. Watt, Theodore M. (Stanford Univ., Calif.). J. Geophys. Res., 71: 3131-40(July 1, 1966).

Using plasma scale height profiles obtained from the Alouette topside sounder and planetary geomagnetic data published in the Journal of Geophysical Research, correlation is observed between K_p and plasma scale height in the topside ionosphere. From the observed correlation it is deduced that nighttime particle temperatures increase by about 4 per cent for each unit increase in K_p and that nighttime midlatitude transition from O^+ ions to lighter (He^+, H^+) ions, normally occurring at around 550 km, rises about 30 km per unit increase in K_p. (auth)

34375 NIGHTGLOW EXCITATION AND MAINTENANCE OF THE NIGHTTIME IONOSPHERE BY LOW-ENERGY PROTONS. Prag, A. B.; Morse, Fred A.; McNeal, R. J. (Aerospace Corp., El Segundo, Calif.). Contract AF 04(695)-669. J. Geophys. Res., 71: 3141-54(July 1, 1966).

The effects of 4-kev protons on the earth's upper atmosphere at midlatitudes were investigated. A Monte Carlo calculation of the flux distribution in the atmosphere, assuming that the initially mono-energetic protons are uniformly mirroring at altitudes where neutralization is important, shows that two-thirds of the incident protons are lost to space and none penetrate to altitudes lower than 135 km. The largest energy deposition occurs near 200 km. An initial flux of 5×10^7 protons cm^{-2} sec^{-1} gives up 10^{-1} erg cm^{-2} (column) sec^{-1} to neutral heating and about 10^{-3} erg cm^{-2} (column) sec^{-1} to electron heating. The calculated intensity of 3914 A radiation is 1.0 R at a magnetic field inclination of 45°; protons and neutrals produce 5.3 R of 6300 A light and 2.0 R of 5577 A light, but the secondary electrons may increase these latter numbers. Equilibrium solutions to the five coupled diffusion equations involving the major atmospheric ions were found both with and without the proton neutral flux. To maintain the nighttime ionosphere above 250 km, 1.2×10^8 ions cm^{-2} sec^{-1} must diffuse down from the exosphere; the additional 4-kev proton flux has little effect. Below 250 km diffusion alone can account for only about 2% of the observed ion concentration; the proton neutral flux can support the ionosphere down to about 150 km, depending somewhat on the magnetic latitude. (auth)

34376 OBSERVATIONS ON PULSATING AURORAS. Cresswell, G. R. (Univ. of Alaska, College); Davis, T. N. Contracts NAS5-9065; AF 33(657)-13703. J. Geophys. Res., 71: 3155-63(July 1, 1966).

Observations on pulsating auroras occurring near the equatorward boundary of auroral displays during their postbreakup phase were made with an image orthicon television system and with photometers. It is found that the pulsating phase of the display is composed of numerous relatively short sequences of pulsations that are restricted to small field-aligned volumes. The luminosity varies synchronously within a given auroral form, but adjacent forms may pulsate asynchronously. (auth)

34377 PRECIPITATION OF ENERGETIC ELECTRONS AT MIDDLE LATITUDES. Paulikas, G. A.; Blake, J. B.; Freden, S. C. (Aerospace Corp., El Segundo, Calif.). Contract AF 04(695)-669. J. Geophys. Res., 71: 3165-72 (July 1, 1966).

Measurements of quasi-trapped electrons with energies greater than 300 kev in August 1964 have extended the temporal observations of these precipitating particles. These electrons are lost in the atmosphere as they drift into the South Atlantic magnetic anomaly. For L = 3.5 and B = 0.40 gauss, typical fluxes of precipitating electrons with energies greater than 300 kev were 10^2-10^3/cm^2-sec in August 1964. For energies greater than 700 kev the flux was less than 10/cm^2-sec in the August 1964-to-April 1965 period. The flux for $E_e > 700$ kev is much lower than that measured in September 1962 and indicates that the spectrum of precipitating electrons has softened considerably between September 1962 and August 1964. Simultaneous measurements of the electric components of longitudinal waves in the 1.7–14.5-kc region were made by a separate experiment; these waves could be effective in precipitating electrons. (auth)

34378 DIFFUSION AND CONVECTION OF ENERGETIC ELECTRONS BEHIND THE EARTH'S BOW SHOCK. Jokipii, J. R. (Univ. of Chicago). J. Geophys. Res., 71: 3173-6(July 1, 1966).

The change in energy spectrum of a group of electrons being convected downwind in the magnetosheath is considered. Recent observations that the spectra of the energetic electron pulses in the magnetosheath soften with increasing LSEP and with decreasing distance from the magnetopause are discussed in terms of a model in which each pulse is due to a group of electrons being blown past the satellite. It is demonstrated that the change in spectrum may be naturally interpreted as a consequence of more rapid diffusion of faster electrons through the turbulent magnetic field of the magnetosheath. In particular, the magnitude of the change is readily explained if the mean free path is of the order of the electron cyclotron radius. Other consequences of the diffusion hypothesis are briefly discussed. (auth)

34379 NIGHTTIME VARIATIONS OF F-REGION ELECTRON DENSITY PROFILES AT PUERTO RICO. 2. AN ATTEMPT TO SEPARATE THE EFFECTS OF TEM-

PERATURE VARIATION AND DRIFT VELOCITY. Shimazaki, Tatsuo (Environmental Science Services Administration, Boulder, Colo.). Contract R-126. J. Geophys. Res., 71: 3177-90(July 1, 1966).

A least-squares method is presented to determine simultaneously the temporal variations in temperature and drift velocity in the ionosphere from the observed temporal variations in electron density profiles. These are determined so that the continuity equation for electron density may be satisfied very well at all heights and at all hours. The application of the method to the nighttime variations of F-region electron density profiles at Puerto Rico, March 1959, indicates that the implied nocturnal variations in temperature and drift velocity are quite reasonable and that the relative significance of these two effects strongly depends upon time; the effect of a rapid temperature decrease predominates over the effect of small drift velocity before midnight, while the effect of a large downward drift velocity overcomes the effect of small temperature variations for several hours after midnight. After around 0400 hours in the morning the temperature rises rapidly and both effects of temperature variation and drift velocity are equally dominant. It remains difficult to reconcile the theoretical value of ambipolar diffusion cross section with rocket observations of neutral atmosphere density and composition on the one hand, and with ionospheric observations on the other hand. (auth)

34380 FIRST-ORDER CORRECTIONS TO D-REGION PROBE THEORY. Hoult, David P.; Kuo, Ta-Jin (Pennsylvania State Univ., University Park). J. Geophys. Res., 71: 3191-3200(July 1, 1966).

The first-order corrections to D-region probe theory are discussed. It is shown that the largest corrections are due to heat transfer and compressibility. These corrections tend to cancel each other for small angles of attack. The largest correction is due to heat transfer and is at most ten per cent. The first-order theory, uncorrected, is valid to within ten per cent. (auth)

34381 EQUATORIAL TRANSMISSION OF GEOMAGNETIC MICROPULSATIONS THROUGH THE IONOSPHERE AND LOWER EXOSPHERE. Field, E. C.; Greifinger, C. (Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 71: 3223-32(July 1, 1966).

The propagation of hydromagnetic waves at altitudes below about 2000 km is considered. The case of plane wave propagation in the vertical direction is treated, and it is assumed that the geomagnetic field is horizontal (equatorial propagation). This is an extension of previous work in which vertical polar propagation was considered. The propagation equations are derived and discussed in detail. A physically realistic analytic representation of the medium permits a solution of the wave equation in terms of known functions. Analytic expressions for the magnetic transmission coefficients are derived, and numerical results are given and compared with experiments. The transmission coefficients are shown to exhibit resonances, although for daytime conditions the resonant peaks are much less pronounced than those found earlier for vertical polar propagation. Low- and midlatitude daytime observations seem to exhibit a resonant structure more characteristic of polar than of equatorial propagation. Some possible reasons for this are suggested. Further, owing to the relatively greater opacity of the ionosphere at low latitudes, the daytime transmission coefficients fall off with increasing frequency much more rapidly than did those computed for high latitudes. On the other hand, the nighttime equatorial coefficients have many of the strong resonance characteristics of the polar ones. This diurnal behavior is in good agreement with the nocturnal appearance of certain classes of low- and midlatitude geomagnetic fluctuations. (auth)

34382 CONJUGATE THREE-DIMENSIONAL POLARIZATION OF HIGH-LATITUDE MICROPULSATIONS FROM A HYDROMAGNETIC WAVE-IONOSPHERIC CURRENT MODEL. Wilson, Charles R. (Univ. of Alaska, College). Contract NONR 3010(02). J. Geophys. Res., 71: 3233-49 (July 1, 1966).

The three-dimensional polarizations of high-latitude micropulsations of 30–300-second period are derived for conjugate point observatories from a simple rotating line current model that represents the actual ionospheric current system induced by circularly polarized standing hydromagnetic waves on the field lines. The sense of polarization in two vertical planes and the orientation of the polarization ellipses are shown to depend on the position of the observing station relative to the terminal point of the oscillating field line. Two classes of conjugate point relations of the senses of polarization in the three orthogonal planes are derived from the model. The type of conjugate relation is shown to depend on the mode of the standing transverse hydromagnetic wave. Polarization diagrams in the H-D, H-Z, and D-Z planes are constructed for Pc-4, Pc-5, and Pg-type micropulsations observed at Kiruna, Sweden, and at the College, Alaska-Macquarie Island conjugate pair to show the agreement of the polarization of high-latitude micropulsations with the predictions of the model. (auth)

34383 ADDITION TO INVESTIGATION OF THE DECAY OF THE STARFISH RADIATION BELT. Walt, M.; Newkirk, L. L. (Lockheed Palo Alto Research Lab., Calif.). Contract DA-49-146-XZ-338. J. Geophys. Res., 71: 3265-6(July 1, 1966).

It is pointed out that a previously observed discrepancy in the altitude dependence of the electron flux in the artificial radiation belt produced by Starfish may be the result of changes produced by the explosion on the belt of naturally trapped protons. The correction for an enhanced proton background is shown to eliminate the major part of the discrepancy. (J.F.P.)

34384 IONOSPHERIC EFFECTS OF ENERGETIC ELECTRON BURSTS IN THE TAIL OF THE MAGNETOSPHERE. Reid, G. C. (Environmental Science Services Administration, Boulder, Colo.). J. Geophys. Res., 71: 3267-72(July 1, 1966).

It is pointed out that there is sometimes a striking correlation between the occurrence of a subclass of auroral absorption events, which were found to be closely associated with the unstable phase of visible auroras, and the appearance of intense bursts of energetic electrons recorded by satellites in the magnetospheric tail. The detailed structure of one of these bursts is shown, and the mechanism for them is considered. (J.F.P.)

34385 EFFECTS OF DIFFERENT FIELD EXPANSIONS ON OMNIDIRECTIONAL PROTON COUNTING RATE DATA. DeForest, S. E. (Univ. of California, San Diego, La Jolla). Contract NASr-116. J. Geophys. Res., 71: 3273-6(July 1, 1966).

Investigations were made to determine the effects of improved expansions of the earth's magnetic field on data that were already reduced using the previous 49-term expansion. The effects of these expansions are given. It is concluded that a significant reduction in data for the scatter of trapped particles can be obtained by the use of these expansions. (J.F.P.)

34386 SIZE OF LOW-LATITUDE IONOSPHERIC IRREGULARITIES DETERMINED FROM OBSERVATIONS OF DISCRETE SOURCES OF DIFFERENT ANGULAR DIAMETERS. Aarons, Jules; Guidice, Donald A. (Air Force Cambridge Research Labs., Bedford, Mass.). Contract AF 49(638)-1156. J. Geophys. Res., 71: 3277-80 (July 1, 1966).

Drifts and driven scans of sources whose angular diameters varied from 29 minutes to less than one minute were taken. A wide range of scintillation indices due to different ionospheric irregularity distributions occurs in records taken from many different observing periods, but there is definite evidence of scintillation dependence on angular diameter. It is found that smaller-source diameters scintillate, while extended sources do not. (J.F.P.)

34387 GEOMAGNETIC AND SOLAR DATA. Lincoln, J. Virginia (ed.). (Environmental Science Services Administration, Boulder, Colo.). J. Geophys. Res., 71: 3337 (July 1, 1966).

Selected geomagnetic and solar data are presented for

February, 1966. These data include geomagnetic planetary 3-hour range indices, magnetic character figures, average amplitudes, Fredericksburg 3-hour range index, and provisional sunspot numbers. (J.F.P.)

34388 DYNAMICS OF THE GEOMAGNETIC TAIL. Coppi, B.; Laval, G.; Pellat, R. (International Center for Theoretical Physics, Trieste, Italy). Phys. Rev. Lett., 16: 1207-10(June 27, 1966).

The stability analysis of a collisionless pinch is applied to the supposed neutral sheet in the geomagnetic tail. A constant perturbation along the equilibrium current lines surrounding the plane of the neutral sheet is postulated. The result of the instability is a reconnection of initially antiparallel magnetic field lines; this occurs through the transfer of macroscopic energy of the plasma to a relatively small number of electrons through microscopic particle-wave resonant processes. The heated electrons lie on a thin sheet along the plane of zero magnetic field. Some indirect evidence for this theory is presented. (G.O.Y.)

34389 OBSERVATION OF AN ENERGY-SELECTIVE REDISTRIBUTION OF TRAPPED ELECTRONS IN THE INNER RADIATION BELT. Imhof, W. L.; Cladis, J. B.; Smith, R. V. (Lockheed Palo Alto Research Lab., Calif.). Planet. Space Sci., 14: 569-77(July 1966).

The sudden appearance of a group of 0.74-Mev trapped electrons was observed at the lower edge of the inner radiation belt, providing information concerning the source of the previously reported nearly monoenergetic electrons at 1.34 Mev. The data suggest that the injection process was an energy selective redistribution of electrons previously trapped on somewhat higher L shells, and that the process was associated with magnetic disturbances. (auth)

34390 PLANETARY MAGNETIC FIELDS. Hide, R. (Massachusetts Inst. of Tech., Cambridge). Planet. Space Sci., 14: 579-86(July 1966).

Present knowledge and modern theories of the earth's main magnetic field are outlined and the state of knowledge of the magnetic fields of the other planets is sketched. (auth)

34391 AURORAL OVAL, THE AURORAL SUBSTORM, AND THEIR RELATIONS WITH THE INTERNAL STRUCTURE OF THE MAGNETOSPHERE. Akasofu, S.-I. (Univ. of Alaska, College). Planet. Space Sci., 14: 587-95(July 1966).

If the neutral sheet is the source region of auroral particles, as suggested by Piddington, they flow in a thin layer just outside the outer boundary of the trapping region from the neutral sheet towards the earth and produce an oval-shape glow on the polar ionosphere, which is identified as the auroral oval. It is shown that the growth and decay of the ring current and the neutral sheet current during geomagnetic storms change the internal structure of the magnetosphere and that it is manifested by changes of the auroral oval, in particular the equatorward shift of the oval during a large main phase decrease and a rapid expansion and the subsequent contraction of the oval width during the auroral substorm. (auth)

34392 ENERGY SPECTRUM OF PRIMARY AURORAL ELECTRONS DETERMINED FROM AURORAL LUMINOSITY PROFILES. Belon, A. E. (Univ. of Alaska, College); Romick, G. J.; Rees, M. H. Planet. Space Sci., 14: 597-615(July 1966).

The vertical luminosity profiles of sixteen auroral arcs were measured in the light of λ3914 (N_2^+) by a technique of photometric triangulation. A comparison between these observed profiles and predicted profiles calculated using two model atmospheres and several electron spectral shapes yields information on the flux and energy distribution of the primary auroral electrons. In the energy range of about 0.1–30 kev the primary electron stream may be characterized by a differential number flux of the form $N(E) \sim E^{\gamma} \exp(-E/\alpha)$ where γ is usually 1 and α varies between 1 and 4 kev. The function has a maximum at energy $E = \gamma\alpha$ which may be interpreted as the characteristic energy of the stream. Thus, the electron stream which produces the luminous aurora has a characteristic energy between 1 and 4 kev, although extreme values of 0.7–6.0 were found in the sixteen cases studied. The energy distribution above 30 kev is not well determined from luminosity data and plays a small part in the auroral luminescence. The total electron flux associated with the sixteen arcs ranged between 2.9×10^9 and 1.1×10^{11} electrons/cm² sec. The total energy flux carried by the incident electrons ranged between 28 and 590 ergs/cm² sec. (auth)

34393 GEOMAGNETIC CAVITY AND THE VAN ALLEN RADIATION BELTS. Viswanathan, K. S. (Dublin Inst. for Advanced Studies. National Aeronautical Lab., Bangalore, India); Venkatarangan, P. Planet. Space Sci., 14: 641-7 (July 1966).

The Störmer's study is extended to examine the motion of a charged particle in a spherically confined magnetosphere. It is shown that the "allowed" region computed on this basis for proton energies ranging from 10 to 710 Mev is in a close agreement with the radial distribution and latitude dependence of the inner zone. A similar study is made also for electrons in the energy range 10–900 kev. (auth)

34394 CORPUSCULAR STREAMS AND COSMIC RAYS OF SOLAR ORIGIN AND THEIR INFLUENCE ON THE TROPOSPHERE. Mustel', E. R.; Kubyshkin, V. V.; Bonelis, I. V. (Astronomical Council, Academy of Sciences, USSR. Volgograd Pedagogical Inst., USSR). Soviet Astron. AJ (Engl. Transl.), 9: 957-70(May-June 1966).

Translated from Astron. Zh., 42: 1232-49(Nov.-Dec. 1965).

Some data on quasi-stationary corpuscular streams, on cosmic rays, and on flares are correlated and analyzed. As a result of this analysis, it is shown that corpuscular streams produce (apparently only over continents) a pressure increase, while subrelativistic proton streams from chromospheric flares produce a pressure decrease at the polar caps. It is to be noted that the amplitude of atmospheric disturbances decreases with decreasing geomagnetic latitude and that this can be an additional source of atmospheric circulation. (G.O.Y.)

34395 ELECTRON PRECIPITATION IN THE AURORAL ZONE. Brown, R. R. (Univ. of California, Berkeley). Space Sci. Rev., 5: 311-87(May 1966).

The present experimental knowledge of electron precipitation in the auroral zone is summarized, using observations primarily from riometer, balloon, rocket, and satellite studies. This includes the association of electron precipitation events with aurora, magnetic disturbances as well as temporal and spatial aspects of the particle bombardment. (auth)

34396 ENERGY TRANSFER AND CHARGED PARTICLE TEMPERATURES IN THE UPPER ATMOSPHERE. Banks, Peter Morgan. University Park, Pa., Pennsylvania State Univ., 1965. 333p.

Thesis.

A study was made to determine the factors that influence the thermal balance of electrons and ions in the upper atmosphere. The energy transfer rates of electrons, ions, and neutral particles arising from elastic, inelastic, and charge-exchange collisions were determined both in theoretical form and with numerical results. The thermal conductivity of the electron gas was altered from the conventional expression valid only for a fully ionized gas, to include the effects of electron-neutral collisions. The problems of energetic electron transport in the earth's magnetic field were studied and equations are derived for the net flux of electrons created by photoionization in the E and F regions of the ionosphere. For daytime conditions, the heating rate of the ionospheric electron gas is derived for three states of solar activity. A calculation is also made of the energy production rate for a region that, while still in darkness, receives a supply of photoelectrons from its conjugate region. With the details of energy production and loss being known, equations for the ionospheric energy balance are written separately for electrons and O^+, He^+, and H^+ ions. These equations, which are coupled by elec-

tron-ion and ion-ion collisions, are solved for each of the solar conditions to obtain electron and three ion temperature profiles. The results are then related to the aeronomic conditions of the ionospheric regions. (Dissertation Abstr.)

34397 MORPHOLOGY OF HIGH LATITUDE GEOMAGNETIC DISTURBANCE AND CORRELATIONS WITH SATELLITE MAGNETIC FIELD MEASUREMENTS. Fairfield, Donald Hobbs. University Park, Pa., Pennsylvania State Univ., 1965. 134p.

Thesis.

Perturbations of the earth's magnetic field in high latitudes. The world-wide high-latitude current patterns on individual days were studied by using the hourly average values of the horizontal field components measured at twelve high-latitude observatories. Data from the twelfth hour Universal Time on each day of the IGY were punched on computer cards and base values representing the undisturbed field were subtracted. The remaining disturbances on individual days were compared by calculating a correlation coefficient which indicated the similarity of any pair of days. Data were grouped according to season and average disturbance magnitudes were computed. The average disturbance vectors were rotated 90° to give the direction of the average current and these current vectors were plotted on polar maps. Variance ellipses were calculated, which indicated how the individual vectors were distributed about the average. The outstanding result was that current on the polar cap is toward the sun in the summer, but is rotated about 40° clockwise (looking down on the North Pole) in the winter. A tentative explanation of this effect suggests that the effect of the solar wind blowing polar cap field lines away from the sun show up during the winter while ionospheric currents toward the sun predominate in the summer when sun light produces a higher conductivity. Also evidence is presented in support of a diurnal variation in the latitude of the intense currents near the auroral zone. Explorer 12 satellite measurements of the magnetic field outside the magnetosphere were converted to geomagnetic coordinates for comparison with simultaneous ground measurements. The result shows that exterior fields with a southward component tend to be associated with high-latitude disturbance, while northward fields are associated with quiet times. It is suggested that the solar wind velocity is the primary cause of the high-latitude disturbance with the exterior field producing a modulating effect. The southward field is apparently a necessary though not a sufficient condition for a substorm. (TCO)

Gravitation, Quantum Mechanics, and Relativity Theory

Refer also to abstracts 34227 and 34293.

34398 NOTE ON VARIATIONAL PRINCIPLE IN BIMETRIC RELATIVITY. Rosen, Nathan (Israel Inst. of Tech., Haifa). Ann. Phys. (N. Y.), 38: 170-4(June 15, 1966).

In bimetric relativity, involving a Riemannian metric tensor $g_{\mu\nu}$ and a flat-space metric tensor $\gamma_{\mu\nu}$, a variational principle can be written which gives the field equations and also leads to a gravitational energy-momentum density tensor. (auth)

34399 ANALYTICAL SOLUTION FOR GRAVITATIONAL COLLAPSE WITH RADIATION. Vaidya, P. C. (Gujarat Univ., Ahmedabad, India). Astrophys. J., 144: 943-52 (June 1966).

An equation which does not depend on the pressure and the density of, and the law of energy transport within, matter is obtained for the potentials g_{ij} of the gravitational field within spherical collapsing matter with radiation. This equation is then solved along with two mathematical assumptions which are chosen to obtain an analytical solution similar in structure to the Oppenheimer-Snyder solution. The solution so obtained is a generalization of this classical adiabatic solution to the non-adiabatic case. Some physical properties possessed by the solution are mentioned. (auth)

34400 REMARKS ON QUATERNION QUANTUM MECHANICS. Jenc, F. (Inst. of Physical Chemistry, Prague). Czech. J. Phys., 16: 555-62(1966).

It is shown that quaternion quantum mechanics can be deduced from a general principle for constructing the mathematical apparatus of a physical theory of submicroscopic events. In the axiomatics of the theory, this principle may be formally characterized by postulating invariance (with respect to the probability function), in propositional calculus, of a certain set endowed with a prescribed "algebraical" structure. (auth)

34401 CAUSAL ANOMALIES IN THE EXTENDED SCHWARZSCHILD MANIFOLD. Israel, W. (Univ. of Alberta, Edmonton, Can.). Phys. Lett., 22: 41(July 15, 1966).

Attention is drawn to errors in a previous paper (W. Israel, Phys. Letters, 21: 46 (1966)) on the extended Schwarzschild manifold, and explicit remarks are made on the line elements for the exterior and interior of the shell. (L.B.S.)

34402 SPINOR CURVATURES IN THE THEORY OF GRAVITATION. Oliveira, C. G.; do Amaral, C. Marcio (Centre Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Phys. Lett., 22: 64-5(July 15, 1966).

The relation between two well-known spinor approaches to the theory of general relativity, namely, the approaches of Witten and Penrose and that of Bergmann are derived. It is shown that both methods are related by simple formulas. The two situations of spaces with matter and empty spaces are briefly analyzed. The relation derived may be useful for further applications of the subject. For instance, they can be useful in the problem of quantization of general relativity. (auth)

34403 A SCHROEDINGER EQUATION EXHIBITING BOTH ROTATIONAL INVARIANCE AND BROKEN SU(3) SYMMETRY. Cusson, R. Y. (California Inst. of Tech., Pasadena). Phys. Lett., 22: 78-82(July 15, 1966).

A Schrödinger equation is proposed, whose geometrical interpretation is the quantization of the dynamics of the linear collective modes of an extended body. Similarities with the levels of particle and nuclear spectroscopy are pointed out. Possible generalizations are discussed. (auth)

34404 SOME ASPECTS OF THE MINIMUM-ENERGY PROBLEM IN GENERAL RELATIVITY. Manasse, F. K. (Princeton Univ., N. J.). Phys. Rev., 147: 887-90(July 29, 1966).

It was previously shown that the energy of a charged point mass is positive-definite and that its metric expressed in isotropic coordinates represents a minimum-energy state. It is found that for an electric field about this particle which can be derived from a scalar potential, this energy is stationary regardless of the form of gravitational wave interaction, in first approximation (small-perturbation theory). Thus, it is expected that for certain metrics, such a state has lower energy, in first order, than one in which any weak external gravitation is included. (auth)

34405 N-REPRESENTABILITY PROBLEM FOR FERMION DENSITY MATRICES. II. THE FIRST-ORDER DENSITY MATRIX WITH N EVEN. Smith, Darwin W. (Univ. of Florida, Gainesville). Phys. Rev., 147: 896-8 (July 29, 1966).

For a quantum-mechanical system of N identical fermions, the N-representability problem is the problem of recognizing whether, for a given pth-order reduced density matrix $\Gamma^{(p)}(12 \ldots p|1'2' \ldots p')$, there exists an antisymmetric N-particle wave function $\Psi(12 \ldots N)$ such that $\Gamma^{(p)}(12 \ldots p|1'2' \ldots p') = \binom{N}{p}\int\Psi(12 \ldots N) \times \Psi^*(1'2' \ldots p', p+1 \ldots N)d\tau_{p+1} \ldots d\tau_N$. It is shown that if the Hamiltonian of a system is time-reversal invariant, and the number of particles, N, is even, the necessary and sufficient condition that an approximate first-order

density matrix corresponding to a nondegenerate energy eigenstate by N-representable is that its natural spin-orbital occupation numbers be equal in pairs. (auth)

34406 COLLECTIVE PROCESSES IN GRAVITATING SYSTEMS. [PART] II. Maksumov, M. N.; Marochnik, L. S. (Astrophysics Inst., Academy of Sciences, Tadzhik SSR). Soviet Astron. AJ (Engl. Transl.), 9: 980-6(May-June 1966).

Translated from Astron. Zh., 42: 1261-9(Nov.-Dec. 1965).

The geometrical-optics approximation is used to derive the dispersion equation for longitudinal waves of small amplitude propagating in a slightly nonhomogeneous system of collisionless gravitating particles. A formula is given for the determination of the critical wavelength in the general case of an arbitrary distribution function. The theorem of stability is formulated. The following particular cases are discussed: a system with a Maxwellian distribution and a system consisting of two interpenetrating Maxwellian streams of particles. The increments which determine the relaxation time are computed for these systems. An application to the galaxy shows that it is unstable in all directions as λ_{cr} is smaller than its dimensions. The time of development of the instability (relaxation) in all directions is apparently of the order of 1.2 to 8.5×10^8 yr. The allowance for collective processes thus reduces the relaxation time in the galaxy to a value which is less than its age. This apparently solves the well-known stellar dynamical paradox. (auth)

34407 ELECTRON RADIATION STIMULATED IN CROSSED FIELDS. Pavlenko, Yu. G. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 50: 1285-90(May 1966). (In Russian).

Stimulated emission and absorption of a relativistic electron in crossed electrostatic and magnetic fields are studied by quantum mechanics methods. The case when emission is greater than absorption is considered. An expression is deduced for the intensity of the stimulated radiation. (auth)

34408 QUANTUM EXTENSION OF THE EXPRESSION FOR ENERGY DISSIPATION. Fain, V. M. (Gor'kii State Univ., USSR). Zh. Eksp. Teor. Fiz., 50: 1327-31(May 1966). (In Russian).

The usual expression for energy dissipation per unit time under the action of external forces is a quadratic function of the forces. It is shown that the expression is valid only in the classical region in which quantum correlations can be neglected. In the general case when quantum correlations cannot be neglected a formula has been derived for energy dissipation which can be expressed in terms of the mean values of quadratic quantities of external forces. The formula is applicable in the classical and quantum regions. (auth)

34409 MONOPOLE-DIPOLE EQUATIONS OF MOTION IN GENERAL RELATIVITY. Roemhild, George Fulton. Bethlehem, Pa., Lehigh Univ., 1965. 155p.

Thesis.

The gravitational equations of motion of mass singularities possessing monopole-dipole moments are investigated in the framework of general relativity. The test particle equations are restudied and it is found that a spurious term exists in the matter tensor, which is introduced by the dipole degrees of freedom, and which is not restricted by the laws of motion. The necessary and sufficient conditions for a unique solution of these equations are given, as well as the sufficient conditions for the case that the usual Frenkel condition on intrinsic angular momentum is imposed. A new fast-motion weak-field approximation method is developed, which differs from the Havas and Goldberg procedure in that the approximated equations of motion at each order transform as tensors under the approximated group of coordinate transformations to that order. The new equations of motion are given explicitly to the second order in the weak field expansion parameter. The Taylor series of the half-retarded minus half-advanced solutions near the singular world line is rederived up to third derivatives. These solutions are used to calculate radiation damping terms for the monopole-dipole equations of motion for the retarded, symmetric, and advanced solution cases. The slow-motion limit of the monopole-dipole equations of motion is found using the Lagrange expansion technique. One formal difference between these equations and those derived by the Einstein, Infeld and Hoffmann method is that the intrinsic angular momentum can enter one order lower than in their method. This leads to a spin-spin interaction in the Newtonian order mediated solely by the Riemann tensor in the translational equation of motion. The two-body problem for the spin-spin interaction is studied and it is found to give an additional small contribution to the periastron advance. (TCO)

34410 DETECTORS FOR DYNAMIC GRAVITATIONAL FIELDS. Forward, Robert Lull. College Park, Md., Univ. of Maryland, 1965. 158p.

Thesis.

Dynamic gravitational fields, their sources, their characteristics, methods of detecting them, and the results of two preliminary experiments aimed at detecting interstellar gravitational radiation are discussed. Three types of dynamic gravitational interactions are considered: one in which a source body is moving with time and therefore its gravitational field varies with time; a second in which the source body is undergoing symmetric rotation and the resulting gravitational field, although not varying with time, still exhibits non-Newtonian gravitational forces due to the symmetric motion; and a third in which the source body is stationary but the detecting body is moving through the spatially varying gravitational field of the first body, thereby observing a time varying gravitational field in its frame of reference. A series of approximations to the Einstein field equations are developed and presented. Two preliminary experiments were carried out to look for interstellar gravitational radiation. One involved using the normal modes of oscillation of the earth as a detecting mass quadrupole. Data from seismological instrumentation were used to place an upper limit on the power spectrum of the isotropically arriving component of the dynamic Riemann tensor of less than 10^{-75} cm^{-4} $(rad/sec)^{-1}$ in the vicinity of one cycle per hour. This is equivalent to a gravitational radiation energy flux of 80 watts/cm^2 (rad/sec). The design and operation of a gravitational radiation detector consisting of a $1\frac{1}{2}$ ton aluminum cylinder isolated from all external energy sources except gravitation radiation are discussed. It was designed so that the gravitational radiation would excite vibrations in the first longitudinal mode. The vibrations were sensed with quartz piezoelectric transducers, amplified with narrow band tuned amplifiers, detected, and recorded. These measurements placed an upper limit on the power spectrum of the isotropically arriving component of the Riemann tensor of less than 10^{-64} cm^{-4} $(rad/sec)^{-1}$ in the vicinity of 1657 cps. This is equivalent to a gravitational radiation energy flux of 0.7 watts/cm^2 (rad/sec). (TCO)

34411 SOME SPECIAL CASES OF EINSTEIN-MAXWELL FIELDS. Nagaraj, Muppinaiya. Bloomington, Ind., Indiana Univ., 1965. 65p.

Thesis.

Special cases that arise in the study of Einstein-Maxwell fields were investigated. Einstein-Maxwell equations in the presence of charge, matter, and pressure are taken in the form $R^{\beta}_{\alpha} - \frac{1}{2}R\delta^{\beta}_{\alpha} = \mu u_{\alpha}u^{\beta} + F^{\beta}_{\alpha} + p\delta^{\beta}_{\alpha}$ (1), where F^{β}_{α} is the momentum-energy tensor of the electromagnetic field k^{μ}_{λ}, μ is the mass, u^{ν} is the time-like velocity vector (unit) and R^{β}_{α} is the contracted curvature tensor. Maxwell's equations in the presence of charge ϵ are considered in the form $\partial_{\lambda}\rho = Q_{\lambda} + \epsilon L_{\lambda}e^{-\rho}$ (2), where ρ as well as the complex vector Q_{λ} are defined in terms of the eigen-elements of k^{μ}_{λ} and the complex vector L_{λ} is defined in terms of u^{ν} and the eigenvectors of k^{μ}_{λ}. Equations (1) and (2) are to be solved for the real parameter $\sigma = [(\rho - \bar{\rho})/2i]$ and charge ϵ, explicitly. This problem is solved under some restrictive assumptions: (1) charge $\epsilon \neq 0$ so that non-source-free E.-M. fields are considered; (2) both the bivector fields $a^{\lambda\mu}$, $b^{\lambda\mu}$ are X_2-forming (this condition is equivalent to $\mathrm{Im}(Q_{\lambda}) = 0$); and

(3) there exists a scalar function α such that αL_λ is a gradient when α is non-vanishing. Results of conditions (2) and (3) are discussed in Chapter II. Chapter III takes up the special case of an E.-M. field of the 2nd class. It turns out that non-source-free E.-M. fields of the 2nd class exist only when the characteristic of R^ν_λ is [(11).11]. There is only one non-source-free E.-M. free field of the first class when the characteristics of the tensor R is [(11)11]. Both these two non-source-free E.-M. fields are exhibited. In the final chapter, it is assumed that the vector L_λ is neither purely real nor purely imaginary. For this to happen, the characteristic of R^ν_λ has to be either [1111] or [112]. A number of special cases are considered. Then it is shown the charge ϵ should vary as the mass along the world-line of a particle. It is also shown that charge ϵ is a differential concomitant of the curvature tensor R^ν_λ. (Dissertation Abstr.)

34412 GRAVITATIONAL COLLAPSE OF ROTATING BODIES. Wagoner, Robert Vernon Jr. Stanford, Calif., Stanford Univ., 1965. 100p.

Thesis.

The evolution of uniformly rotating bodies in which gravitational forces dominate is investigated within the framework of general relativity. In order to provide a background for this study, the solutions for a uniform density spheroid and a thin disk in Newtonian theory are first examined. A new approach is employed in solving the Einstein field equations. The equations are studied on a timelike hyperplane of reflection symmetry within an axially symmetric distribution of perfect fluid. The assumptions of negligible pressure and uniform angular velocity in the hyperplane, as well as a restriction on the development of the metric off the hyperplane, allow the metric of the hyperplane to be reduced to a simple form. An explicit family of solutions is obtained for the evolution in time of this metric at a fixed radius in the comoving coordinate system. These solutions contain as limiting cases, valid throughout the hyperplane, the nonrotating collapse of a uniform density sphere and the Newtonian oscillations of a uniformly rotating thin disk. The solution for collapse from an initially nonrelativistic state reveals that rotation is unable to halve the collapse at a given comoving radius if the ratio of mass interior to that radius to angular momentum per unit mass at that radius is sufficiently large. In that case the contribution of the rotational kinetic energy to the effective gravitational mass becomes more important than the opposing effect of centrifugal force. This leads to a dynamical singularity, in which the proper time derivatives of local radial and circumferential distances become negatively infinite, while the distances themselves remain finite. This gives rise to a repulsive force normal to the plane of symmetry. It is found that light propagated from the origin can never reach the dynamical singularity, but is instead "reflected" back to the origin. Numerical solutions further indicate that if a singularity develops at some radius in the hyperplane, it must also develop at the origin. Finally, these results are compared with the observations of strong radio sources. (Dissertation Abstr.)

34413 SYMMETRY AND GROUP-THEORETICAL STRUCTURE OF THE SIMPLE HARMONIC OSCILLATOR, THE KEPLER PROBLEM, AND THE DIRAC-KEPLER PROBLEM. Schwalm, Dennis Earl. Boulder, Colo., Univ. of Colorado, 1965. 203p.

Thesis.

The obvious and the hidden symmetries underlying certain differential equations that arise in quantum mechanics are studied. It seemed desirable to reconsider some previously solved problems with the aim of possibly establishing a new and useful point of view. Because a knowledge of the minimal symmetry group of a given hamiltonian allows one to completely classify its energy eigenstates and also to express the hamiltonian in terms of the group invariants, there exists the possibility that a knowledge of a symmetry group and a corresponding set of energy eigenstates might allow one to determine the associated hamiltonian. A salient feature of the group-theoretical approach to any problem is the appearance of shift or ladder operators used to generate all of the solutions belonging to a given irreducible representation of the symmetry group. Another method, called the factorization method, exists, which provides a well-defined way of obtaining the ladder operators and the key solutions associated with an ordinary linear differential equation. After a résumé of previous work by other authors, and after a brief summary of essential group-theoretical ideas, it is shown that the operators obtained from the factorization method can be utilized to get constants of motion for the three different physical systems treated. The constants of motion, in turn, lead directly to the underlying symmetry group of the hamiltonian for the system in question. The factorization operators are known from the work of other authors; there exists a close relationship between these operators and the various group operators associated with systems considered. It is shown that a very large category of Lie groups can be excluded from consideration as possible symmetry groups of the Dirac-Kepler hamiltonian. However, the underlying symmetry group for this system cannot be specified. (Dissertation Abstr.)

Low Temperature Physics

Refer also to abstracts 33966 and 34833.

34414 (BNL–940, pp 69-77) LOW TEMPERATURE PROPERTIES OF LIQUID ^{3}He. Glassgold, A. E. (New York Univ., N. Y.).

A review will be presented of simple theoretical concepts and current experimental results on the properties of liquid helium-3 at low temperatures and low pressures. Some of the topics to be covered are the extent of experimental confirmation of Landau's theory of the Fermi liquid; the possible transition into a superfluid phase; the observation of zero sound; and the importance, and present difficulties, in "microscopic" probing of the elementary excitations. (auth)

34415 (IPP–4/31) HOMOGENEITY INVESTIGATIONS ON SUPERCONDUCTING WIRES AND CABLES. Krueger, P.; Oswald, B. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr. 1966. 21p. (CONF-660530–9). Dep. mn.

From 4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy.

Two procedures are described which enable a control of the homogeneity of the copper plating and the magnetization of the superconducting cross section along great lengths of superconducting wires and cables. With the first method irregularities of the copper plating as, e.g., different thickness, holes or separation from the core can be conceived quantitatively. With the second method one can investigate the homogeneity of superconductors according to their magnetic characteristics. The conclusions are discussed which can be drawn from magnetization on the $I_c - H_c$-characteristics. (auth)

34416 (LA–3492) MEASUREMENT OF AN ENHANCED He II FILM FLOW RATE FROM A TURBULENT BATH. Liebenberg, Donald H. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Dec. 5, 1965. Contract W-7405-eng-36. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Observations are reported of the thickness of the superfluid helium film on a metal surface vs height above the bath. The measurements are made by recording the time that helium takes to flow onto a known surface area when supplied by a limiting perimeter. The flow of the film is markedly different depending on the history of the supply helium. The interpretation of these data based on the phase coherence properties between two film connected baths of superfluid helium is presented. (auth)

34417 (N–65-34464) STUDY OF PROPERTIES OF HIGH-FIELD SUPERCONDUCTORS AT ELEVATED TEMPERATURES. Technical Summary Report, June 21, 1964–June 21, 1965. Hecht, R.; Harper, C. M. (Radio Corp. of America, Camden, N. J.). July 26, 1965. Contract NAS8-11272. 37p. (NASA-CR-67157). CFSTI $2.00 cy, $0.50 mn.

An experimental program to study the current-carrying capacity of high-field superconductors at elevated temperatures is described. Currents are induced in the windings of shorted NbZr and Nb_3Sn coils, or in the walls of NbZr, Nb_3Sn, and NbTi tubes, by applying a magnetic field parallel to the sample axis. The critical current density, J_c, is then found to depend on temperature, applied field (applied field sweep rate) and on the defect structure of the superconductor. It is found that various mechanisms will trigger the sudden revision of a sample to the normal state, (flux jump), but that a particular mechanism will dominate in a given sample under given experimental conditions. (auth)

34418 (N-66-16181) EXPERIMENTAL INVESTIGATION OF ADVANCED SUPERCONDUCTING MAGNETS. Annual Report. Hoag, Ethan D. (Avco-Everett Research Lab., Everett, Mass.). July 1965. Contract NAS8-5279. 69p. (NASA-CR-69883). CFSTI $3.00 cy, $0.75 mn.

Solutions are offered for the major obstacles encountered in the use of superconductors of Nb-25% Zr strip for the construction of large magnets. It is shown that anisotropy can be greatly reduced, although not eliminated, by a simple optimum anneal. In the final stages of annealing the lattice is generally softened, which gives rise to a lower normal resistivity and lower critical current. Truncation can be removed by stabilization. Data show that total current tends to be independent of the width of the strip, and truncation is negligible for strips of one millimeter or less in width. Copper stabilization allows the surface current to redistribute uniformly through the width in a stable fashion instead of only along the edges. For much of the short sample testing, the Nb–Zr strip was stabilized by clamping it tightly to the copper during the annealing. Since this results in a weak bond which will not withstand the bending and shock of coil winding, methods of laminating long strips were investigated. A copper plated strip, soft soldered to copper, was found to be most effective; and joints of this type were constructed with resistances well below 10^{-10} ohms. Two small superconducting disk solenoids for coil construction are described which are stable although not optimally designed. (STAR)

34419 (UCRL-14255) DIELECTRIC CABLE USED AS A CRYOGENIC TRANSFER LINE. Denhoy, Balwant S. (Lawrence Radiation Lab., Univ. of California, Livermore). June 25, 1965. Contract W-7405-eng-48. 18p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Ways to adopt an air dielectric coaxial cable for transferring cryogenic fluid (liquid nitrogen) are discussed and the performance of the cable when used as a cryogenic transfer line is evaluated and documented. The criteria used for performance evaluation was the rate of heat leak. The end connections that provide transition between corrugated coaxial and conventional pipe and vacuum closure between the outer and inner conductor of the cable were designed and tested. (auth)

34420 (UCRL-16817) DEPENDENCE OF SUPERCONDUCTING PROPERTIES ON COMPOSITION IN THE NIOBIUM–CARBON–NITROGEN TERNARY SYSTEM. Williams, Molly Wells (Lawrence Radiation Lab., Univ. of California, Berkeley). June 1966. Contract W-7405-eng-48. 71p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Thesis.

Because cubic niobium carbo-nitrides have a wide range of stoichiometries, uncertainty in specimen composition has led to confusing results in previous investigations of these compounds. A better controlled and careful preparative technique, involving several different nitriding pressures, temperatures, and times has made possible a clearer description of superconductive properties of this system. Both lattice parameter and stoichiometry influence the critical temperature. The maximum critical temperature (17.3°K) occurs at a composition, $NbN_{.93-.96}$, corresponding to a lattice parameter of 4.390Å. The variation of T_c with carbon content indicates a broad maximum between 25 and 30 mole % of NbC in NbN, in agreement with previous investigators. There is a possibility that the critical temperature could be raised beyond the maximum found in this study. The importance of electrons per atom as a significant descriptive parameter in the study of superconductivity has been substantiated. The peak critical temperature occurs when there are approximately 4.8 electrons per atom. The maximum critical field (132 kG) was found in a nitride of higher nitrogen content than the optimum based on T_c. At constant nitriding pressure critical temperature decreases with increasing carbon content. This behavior has been tentatively associated with the variation in density of states at the Fermi surface. (auth)

34421 (MATT-Trans-28) INVESTIGATION OF THE MICRORESISTANCE OF SUPERCONDUCTORS. Grassman, P. Translated for Plasma Physics Lab., Princeton Univ., N. J., from Phys. Z., 37: 569-78(1936). 18p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Described is a method for quick measurement of extremely small resistances (to $10^{-15}\Omega$). Its application to the resistance of superconductors below the transition point yields the following: The resistance of a 6.5 μ tin layer on copper at an appropriately low temperature is smaller than $10^{-14}R_z$ (R_z = resistance at room temperature). The resistance of a 3.5 μ layer of lead is smaller than $0.5 \times 10^{-15}R_z$. Even at current densities up to 4×10^5 amp/cm^2 no decrease of current is detectable in this layer. Hence even at high electron velocities no additional energy dissipating effects occur. A lower limit is given for the number of superconducting electrons. (auth)

34422 SUPERCONDUCTING MAGNET DEVELOPMENTS. PART II. Laverick, Charles. Argonne Nat. Lab. Rev., 3: 52-9(Apr. 1966).

The development of superconducting magnets is discussed. Topics included are bonding and shunting materials, conductor working stress, pulsed superconductors, power supplies, flux pumps, safety considerations, persistent switches, refrigeration, predictability of performance, accessibility, and operation at temperatures above and below 4.2°K. Some of the magnets designed and constructed at ANL are described. (B.G.D.)

34423 INFLUENCE OF REACTOR NEUTRON IRRADIATION OF DIFFERENT DOSES ON THE MEISSNER EFFECT IN NIOBIUM. Lautz, Guenter; Metasch, Horst-Dieter (Univ. of Kiel). Atomkernenergie, 11: 295-307 (July-Aug. 1966). (In German).

The changes in the magnetic properties of polycrystalline superconducting niobium in the temperature range from 7 to 9°K after a room temperature bombardment with reactor neutrons of 10^{14} to 10^{17} cm^{-2} integrated flux are dealt with. Measurements of the magnetic induction and the magnetization in function of an external magnetic field show that only neutrons with an energy >1 Mev have a significant effect. An analysis of the experimental results with the Ginzburg-Landau-Abrikosov-Gorkov-theory for type-II-superconductors gives a Ginzburg-Landau-parameter $\varkappa = 1.2$ for the unirradiated Nb and $\varkappa = 1.5 \ldots 1.7$ at $T = T_c$ for specimen irradiated with $7.9 \cdot 10^{14}$ fast neutrons/cm^2. Under these conditions a decrease of 0.29°K in the transition temperature is observed. However, at higher neutron fluxes the transition temperature begins to increase again and the magnetization curves become irreversible: These specimens are type-III-superconductors. Finally the results are discussed with respect to the radiation damage. (auth)

34424 RELATIONSHIP BETWEEN THE SHAPE OF THE HOMOGENEITY REGION OF THE β PHASE IN THE NIOBIUM–TIN SYSTEM AND THE SUPERCONDUCTIVITY CHARACTERISTICS OF Nb_3Sn. Svechnikov, V. N.; Pan, V. M.; Beletskii, Yu. I. (Inst. of Metal Physics, Academy of Sciences, Ukrainian SSR). Dokl. Akad. Nauk SSSR, 166: 1328-31(Feb. 21, 1966). (In Russian).

A series of niobium–tin alloys containing up to 37.5 at. % tin were studied in order to explain the negative effect of annealing at temperatures above 900 to 1000°C on the characteristics of superconductivity of Nb_3Sn compound. Alloys were annealed at 700 to 1800°C for up to 350 hr and quenched. All the alloys containing 16.9 to 37.5 at. % tin were found to consist of a phase with a β-tungsten structure, i.e., Nb_3Sn phase, regardless of the annealing tem-

perature, which proves that this compound is stable at temperatures up to 1800°C. The lattice parameter of Nb_3Sn was found to increase linearly with increasing tin content from 5.2790 Å at 9.3 at. % tin to 5.2875 Å at 34.9 at. % tin. The niobium side of the phase diagram of the niobium–tin system plotted on the basis of experimental results shows that the solubility of tin in Nb_3Sn drops sharply at temperatures below 900°C. On the other hand the critical temperature of the compound appears to depend linearly on the tin content, which was determined from the analysis of some literature data. This explains why the critical temperature of Nb_3Sn increases sharply with annealing temperature increased to 900°C and drops again with a further increase of annealing temperature. (ATD)

34425 TUNNELING IN SUPERCONDUCTING BINARY FILMS. Tsuya, Hideki (Nippon Electric Co., Ltd., Kawasaki, Japan). J. Phys. Soc. Jap., 21: 1011(May 1966).

The energy gaps of Ag-Sn, Fe-Sn, and Sn films were investigated by electron tunneling. The results were compared with values obtained with the BCS theory. (G.O.Y.)

34426 SINGULARITIES OF THE TEMPERATURE DEPENDENCE OF ELECTRIC CONDUCTIVITY OF ALUMINUM AT HELIUM TEMPERATURES. Ch'iang, Yu. N.; Eremenko, V. V. (Inst. of Physics and Tech. of Low Temperatures, Academy of Sciences, Ukrainian SSR). JETP Lett. (USSR)(Engl. Transl.), 3: 293-6(June 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 3: 447-52(June 1, 1966).

The first results of an investigation of the temperature dependence of the resistivity of aluminum by a procedure which affords the required measurement accuracy are presented. The voltage sensitivity of the apparatus is 10^{-11} to 5×10^{-12} v. A singularity in the temperature dependence was found which depends on the purity of the metal. It is shown that a study of this singularity is hindered by the difficulty of obtaining the required range of sample purity necessary to keep the singularity in the helium temperature range at all times. (M.H.R.)

34427 DISLOCATIONS IN THE FLUX LINE LATTICE. Labusch, R. (Univ., Goettingen, Ger.). Phys. Lett., 22: 9-10(July 15, 1966).

It is shown that the hexagonal lattice of flux lines probably contains dislocations as elementary lattice defects. The properties of these "flux line dislocations" are discussed, and a mechanism of multiplication is given. (auth)

34428 THERMAL CONDUCTIVITY OF SUPERCONDUCTING Ta–Nb ALLOYS. Lowell, J. (Clarendon Lab., Oxford). Phys. Lett., 22: 11-12(July 15, 1966).

The superconducting state thermal conductivity of single crystal Ta–Nb alloys agrees well with the sum of lattice and electronic contributions calculated from the theory of Bardeen, Rickayzen and Tewordt. (auth)

34429 HELICON-LIKE RESONANCES IN SUPERCONDUCTING INDIUM PLATES. Druyvesteyn, W. F.; Greebe, C. A. A. J. (Philips Gloelampenfabrieken, Eindhoven, Netherlands). Phys. Lett., 22: 17-18(July 15, 1966).

Experiments on helicon resonances in superconducting indium are discussed in terms of the vibrating flux tube picture, which is phenomenologically extended to include damping. The results are correlated with d-c Hall effect and magnetoresistance data from the literature. (auth)

34430 THE TRANSITION TEMPERATURE OF A THIN TYPE-II SUPERCONDUCTOR IN CONTACT WITH A MAGNETIC METAL. Groff, R. P.; Parks, R. D. (Univ. of Rochester, N. Y.). Phys. Lett., 22: 19-20(July 15, 1966).

Results of the dependence of the superconducting transition temperature on electronic mean free path in a thin alloy superconductor in contact with a ferromagnetic material are in agreement with the predictions of the linearized Ginzburg-Landau theory. (auth)

34431 ULTRASONIC ATTENUATION STEPS IN THE MIXED STATE OF NIOBIUM. Kagiwada, R.; Levy, M.; Rudnick, I. (Univ. of California, Los Angeles). Phys. Lett., 22: 29-31(July 15, 1966).

Ultrasonic attenuation spikes and steps, coincident with temperature spikes and magnetic flux steps were observed in an irreversible niobium single crystal. (auth)

34432 BERNOULLI EFFECT IN SUPERCONDUCTORS. Hunt, T. K. (Ford Motor Co., Dearborn, Mich.). Phys. Lett., 22: 42-3(July 15, 1966).

An electrostatic potential difference should exist between regions of different current density in a superconductor. Such voltages, however, cannot be measured using conventional voltmeters and use of the effect to investigate the superelectron velocity distribution is not feasible. (auth)

34433 COMPLEX SUSCEPTIBILITY OF TYPE-II SUPERCONDUCTORS IN SWEPT FIELDS. Schwartz, B. B.; Maxwell, E. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett., 22: 46-7(July 15, 1966).

An equation is derived for the complex a-c susceptibility for a type II superconductor in the presence of a swept field. The result compares favorably with experiment. (auth)

34434 MEASUREMENT OF THE UPPER CRITICAL FIELD OF VANADIUM–GALLIUM ALLOYS. Montgomery, D. B.; Wizgall, H. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett., 22: 48-50(July 15, 1966).

Measurements on several vanadium gallium alloys in d-c magnetic fields find a maximum upper critical field of 196 kG at 4.2°K. Critical field-temperature curves show the limiting influence of the Pauli paramagnetism on the upper critical field. (auth)

34435 MEASUREMENT OF VELOCITY DISTRIBUTIONS OF ATOMS EVAPORATING FROM LIQUID HELIUM II. Johnston, Wilbur D. Jr.; King, John G. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 16: 1191-3(June 27, 1966).

The velocity distribution of atoms evaporated from liquid He II at 0.59 to 0.70°K was measured in an atomic-beam apparatus, using a chopped beam and time-of-flight method. The data obtained indicate that the Maxwell-Boltzmann distribution is valid for He gas down to 0.6°K and indirectly confirm the validity of the Massey-Mohr scattering theory in the low-energy limit. The evaporating liquid velocities are similarly distributed in the usual modified Maxwellian way, but are characterized by a velocity that would be associated with a gas warmer by 1.0 ± 0.1°K than the actual source temperature. (G.O.Y.)

34436 CRITICAL CURRENTS AND SURFACE SUPERCONDUCTIVITY. Park, J. G. (Imperial Coll. of Science and Tech., London). Phys. Rev. Lett., 16: 1196-1200 (June 27, 1966).

The surface current magnetization and the critical current of a foil carrying a current are calculated. It is found that the critical surface current of foils of a given material should vary at a given field and temperature as $t^{-\frac{1}{2}}$. (G.O.Y.)

34437 ANOMALOUS ULTRASONIC ATTENUATION IN SUPERCONDUCTING SINGLE-CRYSTAL Hg. Thomas, R. L.; Wu, H. C.; Tepley, N. (Wayne State Univ., Detroit). Phys. Rev. Lett., 17: 22-4(July 4, 1966).

Apparent anomalies in the bulk superconducting properties of oriented single-crystal Hg measured by ultrasonic techniques are described. (B.G.D.)

34438 MICROWAVE ABSORPTION STUDIES OF SUPERCONDUCTORS-MAGNETIC-FIELD-INDUCED ANISOTROPY AND THE EFFECT OF IMPURITIES. Budzinski, W. V.; Garfunkel, M. P. (Univ. of Pittsburgh). Phys. Rev. Lett., 17: 24-7(July 4, 1966).

Experimental results are presented on the effect of electron free path on the magnetic-field-induced anisotropy of the energy gap as measured by h-f ($h\nu \sim 2\Delta$) microwave absorption in silver-doped aluminum. These results, along with previous results on pure aluminum, are shown to help substantiate the basic physical postulate used by Maki in his theory of the magnetic-field dependence of the l-f microwave absorption in superconductors. (B.G.D.)

34439 LIFETIMES OF QUASI PARTICLES OF HIGH MOMENTUM IN LIQUID ^{3}He. Emery, V. J. (Brookhaven

National Lab., Upton, N. Y.). Phys. Rev. Lett., 17: 125-6 (July 18, 1966).

An argument is presented which casts some doubt upon the conclusion of Cohen and Abrahams (Phys. Rev. Letters 16: 931(1966)) that quasiparticle lifetimes are sufficiently short to reverse the prediction that liquid ^{3}He would undergo a fermion superfluid phase transition as a result of scattering in relative D states. (B.G.D.)

34440 RELAXATION TIME, EFFECTIVE MASS, AND STRUCTURE OF IONS IN LIQUID HELIUM. Dahm, Arnold J. (Univ. of Minnesota, Minneapolis); Sanders, T. M. Jr. Phys. Rev. Lett., 17: 126-30(July 18, 1966).

The momentum relaxation time of ions in liquid helium II was measured by a microwave technique involving microwave conductivity due to a collection of ions introduced into a reflection cavity, resonant at approximately 9.3 GHz. This new measurement technique, in combination with existing data on ion mobilities, makes it possible for the first time to evaluate the effective masses of the carriers. (B.G.D.)

34441 ELECTROMAGNETIC PROPERTIES OF SUPERCONDUCTORS IN THE FROEHLICH HAMILTONIAN MODEL. Kresin, V. Z.; Litovchenko, V. A. (Patrice Lumumba Univ., Moscow). Phys. Status Solidi, 15: 777-81(June 1, 1966).

A general gauge invariant expression for the superconductive current density is derived. The treatment is based on the Fröhlich hamiltonian taking into account the electron–phonon interaction. The results are used to describe the electromagnetic properties of the anomalous superconductors (Pb and Hg), in which the electron–phonon interaction is strong. For this case, the usual treatment based on the Bardeen hamiltonian cannot be employed. The results are in satisfactory agreement with the experimental data. (auth)

34442 TUNNELING IN SUPERIMPOSED FILMS. Hauser, J. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Physics, 2: 247-61(June 1966).

Tunneling experiments were performed on superimposed films of Pb–Al, Pb–Cd and Pb–Pt deposited and kept at 77°K until measured. The gap in the density of states induced by a 900 Å thick lead film in the Al, Cd, and Pt films was measured as a function of their thickness. The experiments are in fairly good agreement with McMillan's theory, which was derived for pure films and scattering at the normal-superconducting interface. On the other hand, gapless superconductivity was observed in lead films in contact with nickel and platinum films. The degree of gapless superconductivity (i.e., the density of states in the lead gap) was measured from dV/dI versus V curves as a function of the lead film thickness. As expected, a magnetic metal such as nickel has a larger effect on the density of states than a normal metal such as platinum, even if the effect is measured in sandwiches with the same transition temperature. The degree of gapless superconductivity in any of the sandwiches can be increased by applying a magnetic field; the relative conductance ρ_s/ρ_n (which is a measure of the degree of gapless superconductivity) increases linearly with magnetic field close to the upper critical field as predicted theoretically by Maki. (auth)

34443 HIGH-TEMPERATURE SP-BAND SUPERCONDUCTORS. Geballe, T. H.; Matthias, B. T.; Remeika, J. P.; Clogston, A. M.; Compton, V. B.; Maita, J. P.; Williams, H. J. (Bell Telephone Labs., Murray Hill, N. J.). Physics, 2: 293-310(June 1966).

The superconductivity, low-temperature heat capacity, and magnetic susceptibility of a number of face-centered cubic nitrides and carbides of niobium were studied. In agreement with earlier work it is found that the closer the approach to stoichiometry the higher the transition temperature. The values of the electronic heat capacity coefficient and magnetic susceptibility are unusually low and are accounted for by a proposed model in which the carriers are predominantly in sp-bands. Insofar as its superconducting properties are concerned the most stoichiometric nitride, $NbN_{0.91}$, may be considered as a sort of "stiff lead." A superconducting transition temperature of 18°K is found by extrapolation to hypothetical stoichiometric NbN which reinforces the empirical suggestion that 18°K may be an upper limit for the occurrence of superconductivity. (auth)

34444 SUPERCONDUCTING ALLOYS OF INTERSTITIAL COMPOUNDS. Pessall, N.; Hulm, J. K. (Westinghouse Research Labs., Pittsburgh). Physics, 2: 311-28 (June 1966).

The preparation and evaluation of some interstitial compounds are described and their potential as high transition-temperature superconductors is discussed. An evaluation of transition-temperature measurements of pseudo-binary and ternary interstitial alloys shows that no simple direct relation exists between transition temperature and such quantities as valence electron-atom ratio, mass and lattice volume. However, the experimental data were successfully systematized in terms of a general empirical model which appears capable of predicting the most promising materials for attaining high transition temperatures. Preliminary data demonstrate that a large number of alloyed interstitial compounds exhibit transition temperatures in the vicinity of 18°K. (auth)

34445 CRYOGENICS. Bender, R. J. Power, 110: No. 7, 163-70(July 1966).

Low temperature phenomena especially superconductivity are considered. Topics covered include a brief history of cryogenics, refrigeration and liquefaction at very low temperatures including various methods and materials, the handling of cryogenic products, superconductors, supermagnets, MHD cells, and the method of adiabatic demagnetization. (J.F.P.)

34446 SUPERCONDUCTORS: SUPERCONDUCTING AND OTHERWISE. Cooper, L. N. (Ecole Normale Superieure, Paris). pp 370-98 of Recent Developments in Particle Symmetries. Zichichi, A. (ed.). New York, Academic Press, 1966.

A review is given of some of the phenomena and theory that led to constructing a theory of superconductivity. Some recent developments are also discussed. (L.B.S.)

34447 CONTRIBUTION TO THE DESIGN OF SUPERCONDUCTING WINDING TRANSFORMERS. Mailfert, Alain. Rev. Gen. Elec., 75: 315-33(Mar. 1966). (In French).

A procedure for the design and development of superconducting winding type transformers is introduced. After considering the cryogenic problems involved and recalling some properties of the superconducting materials submitted to a-c phenomena the type of winding corresponding to the highest specific capacity of the unit is defined. A first development is further described. (auth)

34448 DEPAIRING EFFECTS IN ROTATING SUPERCONDUCTORS. Griffin, A. (Univ. of California, San Diego, La Jolla). Contract AF-AFOSR-610-64. Solid State Commun., 4: 245-7(May 1966).

Maki's discussion of the depairing effects of persistent currents and magnetic fields is used to study a rotating superconducting cylindrical film. (auth)

34449 DEGRADATION OF LOW-FREQUENCY ALTERNATING CURRENTS IN NON-IDEAL TYPE-II SUPERCONDUCTORS. LeBlanc, M. A. R.; Mattes, H. G. (Univ. of Southern California, Los Angeles). Solid State Commun., 4: 267-9(June 1966).

Nonideal type II superconductors exhibit considerable critical current degradation for currents of very low frequency but of varying polarity in static longitudinal magnetic fields. It is argued that the threshold amplitude required for the abrupt onset of degradation measures the longitudinal current carrying capacity of a surface sheath existing throughout the mixed state. (auth)

34450 SUPERCONDUCTORS FOR POWER ENGINEERING. Appleton, A. D. (International Research and Development Co., Ltd., Newcastle upon Tyne, Eng.). Times Sci. Rev., No. 60, 6; 9(Summer 1966).

A review of the development of superconductors is given.

Applications of type-II superconductors for MPD power generation are discussed. The stable superconductor, production of superconductors in the United Kingdom, and applications of stable superconductors are covered. (J.F.P.)

34451 PRESSURE DEPENDENCE OF THE SUPERCONDUCTING TRANSITION IN ZINC. Brandt, N. B.; Ginzburg, N. I. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 50: 1260-4(May 1966). (In Russian).

The effect of uniform pressure on the superconducting transition temperature T_k in zinc is investigated at pressures up to 26,000 atm. The superconducting transition temperature at 26,000 atm is lower by 2.7 times. It is shown that an exponential function most satisfactorily describes the dependence of T_k on pressure. The possibility of transferring a superconductor to the normal state by subjecting it to pressure is discussed. (auth)

34452 FORMATION OF VORTEX NUCLEI IN TYPE-II SUPERCONDUCTORS. Galaiko, V. P. (Kharkov State Univ.). Zh. Eksp. Teor. Fiz., 50: 1322-6(May 1966). (In Russian).

Due to stability of the superconducting state with respect to small fluctuations of the ordering parameter, transitions to the mixed state in superconductors of the second kind occur in magnetic fields as a result of sufficiently large fluctuations. The vortex lines in this case are produced near the surface and penetrate into the superconductor. A minimal critical size of the vortex nucleus exists for which it is not closed up and continues to develop further. It is shown that the shape of the vortex line and the magnitude of the energy barrier for the nucleus is determined by two main factors: by interaction between the vortex and magnetic field and by the elasticity of the vortex line. In this case the vortex line forms a semi-circle the ends of which touch the superconductor surface. The magnitude of the energy barrier which is surmounted during formation of the vortex is calculated and it is shown that the barrier vanishes for a critical current on the surface, that is, when the superconducting state becomes unstable with respect to small fluctuations. (auth)

34453 ABSORPTION OF A HIGH-FREQUENCY FIELD IN PURE SUPERCONDUCTING FILMS. Ovchinnikov, Yu. N. (Moscow Inst. of Physics and Tech.). Zh. Eksp. Teor. Fix., 50: 1364-8(May 1966). (In Russian).

The dependence of the ordering parameter Δ on the magnetic field strength in thin superconducting films is found. A comparison with the experimental values of Δ obtained in experiments on absorption of a high frequency field is carried out. (auth)

34454 ON THE DYNAMICS OF A SUPERFLUID FERMI GAS. II. STATIC EQUATIONS AT FINITE TEMPERATURES. Kemoklidze, M. P. (Inst. of Physics, Academy of Sciences, Georgian SSR). Zh. Eksp. Teor. Fiz., 50: 1369-76(May 1966). (In Russian).

A static nonlinear differential equation for the characteristic parameter (gap) Δ in a superfluid Fermi gas at finite temperature is derived by taking into account the motion of the normal component and the presence of a magnetic field. The behavior of the gap $\Delta(r)$ at large distances from the vortex line is determined for arbitrary temperatures. (auth)

34455 SURFACE TENSION OF WEAK HELIUM ISOTOPE SOLUTIONS. Andreev, A. F. (Inst. of Physical Problems, Academy of Sciences, USSR). Zh. Eksp. Teor. Fiz., 50: 1415-19(May 1966). (In Russian).

A change in the surface tension of liquid helium due to dissolution of small amounts of an impurity is detected. The change is negative or positive depending on the presence of surface impurity levels. The experimental data indicate the presence of surface levels in solution of ^{3}He in ^{4}He and apparently their absence in solutions of ^{4}He in ^{3}He. (auth)

34456 SOUND ABSORPTION IN THE INTERMEDIATE STATE OF SUPERCONDUCTORS. Andreev, A. F.; Bruk, Yu. M. Zh. Eksp. Teor. Fiz., 50: 1420-4(May 1966). (In Russian).

Propagation of sound in the intermediate state is accompanied by movement of the interface between the phases. As a result eddy currents appear in the normal layers. The Joule heat which is liberated in this case leads to additional absorption of sound. It is shown that at low sound frequencies ($\delta \gg a$, where δ is the skin layer thickness, and a is the spacing of the intermediate state structure) the absorption is proportional to the square of the frequency and at not very small values of a it exceeds the ordinary absorption related to the electron viscosity. At high frequencies ($\delta \ll a$) the additional absorption is proportional to the square root of the frequency. (auth)

34457 BEHAVIOR OF A BOSE FLUID IMMEDIATELY ABOVE ITS CRITICAL TEMPERATURE. Sikora, Paul Thomas. Boulder, Colo., Univ. of Colorado, 1965. 140p. Thesis.

A study of the properties of a low-density hard-sphere Bose gas is made. First a few of the salient features of the quasiparticle spectrum of the Bose fluid are derived from elementary physical considerations. It is shown that the quasiparticles of low momentum cannot be free particles, but must be some type of collective phenomenon. The spectrum is next calculated from quantum statistical mechanics using the Λ-transformed theory due to F. Mohling. The agreement of these results with those expected from physical arguments shows that the Λ-transformation is capable of extracting the dominant low-temperature behavior of the system and that it, in fact, acts as a transformation to the quasiparticle representation. The equation of state and the thermodynamical properties of the hard-sphere gas are calculated. The Bose-Einstein critical temperature for the system may be derived by inversion of a series. A discussion illustrates the manner in which the Λ-transformation eliminates unphysical divergences peculiar to systems with Bose-Einstein statistics. The most striking thermodynamical result obtained is the demonstration that the specific heat of the hard-sphere gas at constant pressure exhibits a cusp at the critical temperature. This type of behavior bears a qualitative resemblance to the λ-point of helium-4. An examination of the experimental data on the specific heat of ^{4}He suggests that the λ-point is actually a cusp rather than a singularity. The radial distribution function for the system is calculated near the critical temperature. Finally, expressions are given for the thermodynamic properties of helium I. The insight provided by the hard-sphere gas calculations is used to predict some of the features that these expressions should exhibit when calculated. (Dissertation Abstr.)

34458 STUDY OF ALTERNATORS WITH SUPERCONDUCTING FIELD WINDINGS. PART II. EXPERIMENT. Stekly, Z. J. J. (Avco-Everett Research Lab., Everett, Mass.); Hatch, A. M.; Woodson, H. H.; Hoppie, L. O.; Halas, E. New York, Inst. of Electrical and Electronics Engineers, 1965, Preprint No. 31 CP 65-723, 14p., $1.00. (CONF-650669-1). ORAU.

From IEEE Summer Power Meeting, Detroit.

The properties and performance of an experimental alternator are discussed. The object was to establish the fact that superconducting field windings can be used successfully in alternators, to verify the performance characteristics, to obtain a measurement of the various losses in the machine, and to examine some of the fabrication problems. (B.G.D.)

34459 NEUTRON IRRADIATION OF SUPERCONDUCTORS. Oberly, Charles E. (Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio). 48p. (CONF-651067-2). ORAU. Gmelin, AED-CONF-65-351-3.

From 12th Annual Air Force Science and Engineering Symposium, Brooks AFB, Tex.

An experiment is described which involves the irradiation of high-field superconductors by high-energy neutrons from controlled thermonuclear reactions. (B.G.D.)

34460 EFFECT OF QUASIPARTICLE LIFETIME ON THE SUPERFLUID TRANSITION TEMPERATURE OF ^{3}He. Cohen, Roger W.; Abrahams, Elihu (Rutgers Univ., New Brunswick, N. J.). 10p. (CONF-660107-27). ORAU. Gmelin, AED-CONF-66-003-67.

From American Physical Society Meeting, New York.

In order to explain the absence of superfluidity of ^{3}He for temperatures as low as 0.0035°K many authors attempted to take into account the effects of finite lifetimes and assumed that the momentum dependence of the bare particle interaction potential $V(\vec{q})$ could be neglected. It is shown that if this assumption is not made, it is likely that the lifetime effect is sufficient to prevent an $l = 2$ state condensation and thereby reduce the transition temperature many orders of magnitude. (B.G.D.)

34461 EFFECT OF UNIAXIAL TENSION ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF TIN. Davis, J. H.; Skove, Malcolm J.; Stillwell, E. P. (Clemson Univ., S. C.). 7p. (CONF-660107-28). ORAU. Gmelin, AED-CONF-66-003-65.

From American Physical Society Meeting, New York.

Using high tensile strength of tin whiskers the shift in superconducting transition temperature due to elastic strain along the (100) direction up to 10,000 atm was measured. (B.G.D.)

34462 INTRINSIC HYSTERESIS IN A COPPER PLATED TYPE II SUPERCONDUCTOR. Gittleman, Jonathan I.; Rosenblum, Bruce (RCA Labs., Princeton, N. J.). 6p. (CONF-660107-31). ORAU. Gmelin, AED-CONF-66-003-53.

From American Physical Society Meeting, New York.

The relation of intrinsic hysteresis with the surface order parameter in several copper plated Pb-In superconducting alloys is investigated. The results not only show an intimate connection between the hysteresis and the surface order parameter, but demonstrate two different forces which can be exerted on vortices. (B.G.D.)

34463 STUDY OF ALTERNATORS WITH SUPERCONDUCTING FIELD WINDINGS. PART I. ANALYSIS. Woodson, H. H. (Avco-Everett Research Lab., Everett, Mass.); Stekly, Z. J. J.; Halas, E. New York, Inst. of Electrical and Electronics Engineers, 1965, Preprint No. 31 CP 65-722, 16p., $1.00. (CONF-650669-2). ORAU.

From IEEE Summer Power Meeting, Detroit.

A detailed set of design formulas for alternators with superconducting field windings is given and some trial designs are presented. The formulas are approximate ones that identify the important design parameters and predict trends. Conservative values are assumed for the numerical design parameters in the trial designs. (M.H.R.)

34464 SPIN SCATTERING IN DILUTE SUPERCONDUCTING ALLOYS. Hedgcock, F. T. (McGill Univ., Montreal). 16p. (CONF-650653-16). ORAU. Gmelin, AED-CONF-65-170-32.

From American Physical Society, Summer Meeting, New York.

An outline is presented on the information relative to the exchange interaction between the conduction and the nonitinerant electrons in the unfilled inner shell of the paramagnetic ions in compound superconductors that can be derived from the experimental results on a system which shows both low temperature resistance anomalies and superconductivity. (B.G.D.)

34465 THERMAL CONDUCTIVITY OF TYPE II SUPERCONDUCTORS IN THE GAPLESS REGION. Dubeck, L.; Lindenfeld, P.; Lynton, E. A. 7p. (CONF-660107-13). ORAU. Gmelin, AED-CONF-66-003-39.

From American Physical Society Meeting, New York.

The thermal conductivity of a number of bulk indium-bismuth and niobium samples are measured as a function of temperature and applied magnetic field. All samples were type II superconductors. (B.G.D.)

34466 DENSITY MATRIX METHODS IN QUANTUM PHYSICS. Coleman, A. J. (Queen's Univ., Kingston, Ont.). 74p. (CONF-650834-1). ORAU. Gmelin, AED-CONF-65-230-1.

From Alberta Symposium on Quantum Chemistry, Edmonton, Ont.

The significance of reduced density matrices is discussed, and the present state of the N-representability problem is reviewed. The interpretation of the observed elementary excitation spectrum of ^{4}He by means of pairons is presented. It is shown that this method provides an adequate framework to understand recent works on the theory of superconductivity. (B.G.D.)

Neutron Physics

See also REACTOR TECHNOLOGY — Criticality Studies

Refer also to abstracts 34932, 34955, and 35001.

34467 (AECL-2557) THE INTENSE NEUTRON GENERATOR STUDY. Lewis, W. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1966. 5p. (DL-70). Dep. mn. AECL $0.20.

The study has confirmed that a beam of 65 ma of protons at 1000 Mev, striking a molten lead-bismuth target surrounded by heavy water moderator, would give the desired flux of 10^{16} thermal neutrons per cm^2 per second to provide intense beams of neutrons and also to produce radioisotopes. The proton beam passing through a thin auxiliary target would also produce beams of mesons. (B.G.D.)

34468 (BNL-940, pp 175-8) DENSITY EXPANSION OF THE SELF-CORRELATION FUNCTION FOR THERMAL NEUTRON SCATTERING IN DILUTE SYSTEMS. Sigmar, D. J. (Technische Hochschule, Vienna (Austria). Institut fuer Theoretische Physik).

In inelastic scattering one wants to know the correlation functions $\gamma(\kappa,t) = \langle \exp[-i\kappa \cdot r(0)] \exp[i\kappa \cdot r(t)] \rangle$; $\langle v(0) \cdot v(t) \rangle$. The short-time expansions of these quantities are calculated for Lennard-Jones interaction of the atoms in powers of the density of the system. How the long-time values of these functions can be derived is also discussed. (auth)

34469 (DP-MS-66-30) DIFFUSION LENGTH AND NEUTRON TEMPERATURE MEASUREMENTS IN BORON-POISONED H_2O AND D_2O. Baumann, N. P.; Pellarin, D. J. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). June 1, 1966. Contract AT(07-2)-1. 25p. (CONF-660606-8). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Nuclear Society Meeting, Denver.

Relaxation length and neutron temperature measurements are reported for B_2O_3 poisoned H_2O and D_2O. The results of these measurements were compared to recently published H_2O data of Burkart. Computations with Monte-Carlo and integral transport codes were used as a basis for further discussion concerning both the scattering kernel and the source feed. (B.G.D.)

34470 (EUR-2953.e) SURVEY MEASUREMENTS ON THE OPTIMALISATION OF THE SCATTERER SHAPE FOR A COLD NEUTRON SOURCE. Olivi, L.; Misenta, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 12p. Dep. mn.

The output of subthermal neutrons was measured for differently shaped lucite samples in a graphite stack which simulated a tangential beam hole of a reactor. The samples were cooled to liquid nitrogen temperature. The obtained values were normalized to the output of a circular slab by the introduction of a shape factor. The measurements show that an elliptical slab in the reflection position and a black body shaped scatterer have gain factors by 20-50% higher than a circular scatterer of the same thickness. The usual gain factor, which is defined as the neutron output at high temperature to that at low temperature is for all shapes between 2.5 and 3. (auth)

34471 (GA-7064) MEASUREMENT OF NEUTRON SPECTRA IN LIQUID HYDROGEN. Quarterly Progress Report for the Period Ending March 17, 1966. Trimble, G. D.; Houghton, G. K. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Mar. 1966. Contract NAS 3-6217. 65p. (NASA-CR-54977).

Further research developments are reported on the liq-

uid hydrogen facility, the water-cooled isotropic fast neutron source, the fast neutron source monitor, the probe tube alignment mechanism, background plug used for the thermal neutron spectrum measurements, theoretical calculations of neutron spectra, and neutron spectrum measurements by time-of-flight techniques. (M.O.W.)

34472 (UCRL-14921-T) EVALUATION OF SOME OF THE APPROXIMATE THEORIES OF PARTICLE TRANSPORT. Terrall, J. R. (Lawrence Radiation Lab., Univ. of California, Livermore). Mar. 1966. Contract W-7405-eng-48. 36p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A previous formulation of transport theory, derived a generalized relation between the particle or energy current-spectrum and the flux spectrum. By explicitly exhibiting terms which are usually neglected, this so-called transport operator theory allows a direct examination of various approximate theories. The ones evaluated here are (a) elementary diffusion theory, (b) transport-corrected diffusion theory, (c) one-velocity theory, (d) Case-de Hoffman-Placzek theory, and (e) the P_L approximations. Some of these approximate theories turn out to have a wider range of validity than is usually ascribed to them. For example, by suitably calculating certain parameters, the form of one-velocity theory can be used (under certain restrictions), even when energy changes are involved. (auth)

34473 JACOBI POLYNOMIAL SOLUTION OF THE ONE-DIMENSIONAL AND MONOENERGETIC BOLTZMANN EQUATION. Nonnenmacher (Technische Hochschule, Karlsruhe, Ger.). Atomkernenergie, 11: 263-9 (July-Aug. 1966).

The Spherical Harmonics Method consisting of an expansion of the angular part of the Boltzmann equation in a series of Legendre polynomials will be generalized to an expansion in Jacobi polynomials. The characteristic equation of this method will be given in a closed form for any order of approximation. It will be shown that this equation converges to the exact characteristic equation of the discrete spectrum of eigenvalues in the case of an infinite high-order approximation. The set of partial solutions of the Jacobi polynomial expansion will be calculated. The error source term will be determined and its distribution over the angular range will be calculated asymptotically. The discussion of this result shows that some sets of Jacobi polynomial systems can be expected to give better results than the system of Legendre polynomials. This is interesting for transport problems with strong absorption. (auth)

34474 STRUCTURE OF A TRANSPORT SOLUTION. Mueller, K.-H. (CCR-EURATOM, Ispra, Italy). Atomkernenergie, 11: 339-40(July-Aug. 1966).

An analytical approach to the linear transport problem is attempted. This approach clarifies the possible mathematical structure of the required transport solution and gives, in addition, a check for the approximation. (M.H.R.)

34475 EPITHERMAL NEUTRON SLOWING-DOWN DISTRIBUTION IN HETEROGENEOUS MEDIA. Coppi, B.; Francesio, M. (Univ., Milan). Energ. Nucl. (Milan), 13: 291-303(1966).

A numerical program is proposed which computes the slowing-down distribution function and average macroscopic cross-sections for media which can be considered as heterogeneous and are moderated by hydrogen. The calculation of the resonance absorption is considered as the most relevant point, on which the program has to be improved in comparison to pre-existing ones. For this, a critical presentation of known theories on neutron slowing-down and resonance absorption is given, starting from the neutron kinetic equation. A consistent basis for the computational program is then provided. Its novel features consist of an accurate analysis of the various types of resonances (narrow, large, unresolved, etc.), and of taking into account the effects of heterogeneity (shielding, etc.). A comparison of the results obtained from this program with those due to similar widely used codes have shown a gain in accuracy, while comparisons of the same results with those obtained using Monte Carlo methods show evident gain in computing time without appreciable loss of accuracy. (auth)

34476 EXACT BOUNDARY CONDITIONS IN THE AGE THEORY. Marchi, E.; Zgrablich, G. (Facultad de Ciencias, San Luis, Argentina). Energ. Nucl. (Milan), 13: 329-30(1966).

The age theory for neutron slowing down is considered without capture and time variations. (B.G.D.)

34477 ON THE PROBLEM OF DETERMINING TIME-DEPENDENT NEUTRON FIELDS IN TIME-DEPENDENT MEDIA. III. Barz, H.-U. (Bereich Theoretische Physik, Rossendorf, Ger.). Kernenergie, 9: 88-95(Mar. 1966). (In German).

Approximation solutions for the basic and generalized kinetic equations are derived. The completeness in homogeneous media of the multigroup diffusion approximation is considered. (J.S.R.)

34478 ACCELERATOR BASED VERY INTENSE NEUTRON SOURCES. Bartholomew, G. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 458-74 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

The Intense-Neutron Generator being studied at Chalk River is described. Comparisons are presented on the relative merits of current methods of achieving intense neutron sources using accelerators. (B.G.D.)

34479 LOGICAL AND IMMEDIATE GENERALIZATION OF THE ELEMENTARY THEORY OF TIME-DEPENDENT DIFFUSION IN THE CASE OF FIRST ORDER ANISOTROPY IN ELASTIC SCATTERING. Oezemre, Ahmed Yueksel (Teorik Fizik Kuersuesue, Istanbul). Nukleonik, 8: 216-18(May 1966). (In French).

In a preceding article a differential equation which constitutes a generalization of the elementary order of the time-dependent neutron scattering in the case where the elastic scattering has an anisotropy of the first order, was established on the basis, partially, of the expression of the neutron current obtained in the framework of the P_1 approximation by a purely geometric method and partially from the results of the P_1 approximation of the equation of the time-dependent monokinetic neutron transfer. The new equation thus obtained confirms the elementary equation of isotropic scattering as a particular case corresponding to $\mu_0 = 0$, which is not possible with the equation furnishing the transport theory in the same approximation. In the present article, an integro-differential equation is established by a purely synthetic method. This equation constitutes the logical and immediate generalization of the elementary equation of the time-dependent neutron scattering in the case of first-order anisotropy in the elastic scattering. This equation, although established on a totally different basis, is shown to be completely equivalent to that of the preceding article. (tr-auth)

34480 SLOW-NEUTRON WIDTH OF 200-Mev VIBRATION LEVEL IN LIQUID H_2O. Harling, O. K. (Battelle Memorial Inst., Richland, Wash.). Phys. Lett., 22: 15-16(July 15, 1966).

A resolved vibration mode at 200 mev was observed in H_2O with slow-neutron down-scattering techniques. The energy width of this level has been measured to be 24.8 ± 0.3 mev. (auth)

34481 ACCURACY OF THE S_2 EQUATIONS IN TWO-DIMENSIONAL GEOMETRY. Lathrop, K. D. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 112(June 1966).

34482 SOURCE-FREE SOLUTIONS TO THE MONOENERGETIC TRANSPORT EQUATION FOR A PLANE LATTICE. Leonard, Anthony (Rand Corp., Santa Monica, Calif.). Trans. Amer. Nucl. Soc., 9: 112-13(June 1966).

34483 SOLUTION OF THE TRANSPORT EQUATION WITH ANISOTROPIC SCATTERING IN SLAB GEOMETRY. Bowden, Robert L. (Virginia Polytechnic Inst., Blacksburg); McCrosson, F. Joseph; Rhodes, Edgar A. Trans. Amer. Nucl. Soc., 9: 113-14(June 1966).

34484 NEUTRON-WAVE ANALYSIS IN VARIOUS MULTIGROUP TRANSPORT APPROXIMATIONS. Travelli, A. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 114-15(June 1966).

34485 METHOD OF INCLUDING EPITHERMAL NEUTRON SCATTERING BY BOUND PROTONS IN COMBINED SLOWING DOWN THERMAL CALCULATIONS BY MONTE CARLO. Candelore, N. R.; Gast, R. C. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 117(June 1966).

34486 RELATIVE MERITS OF IMPULSE AND MODULATED SOURCES IN THERMAL-NEUTRON WAVE EXPERIMENTS. Booth, Ray S. (Air Force Inst. of Tech., Wright Patterson AFB, Ohio); Perez, Rafael B.; Hartley, Robert. Trans. Amer. Nucl. Soc., 9: 173(June 1966).

34487 SPATIAL DEPENDENCE OF NEUTRON SLOWING DOWN TIMES IN WATER. Chen, S. (City Coll., New York); Lidofsky, L. Trans. Amer. Nucl. Soc., 9: 173-4 (June 1966).

34488 SPACE-DEPENDENT SLOWING DOWN TIME MEASUREMENTS. Adamantiades, A. G.; Clikeman, F. M.; Rasmussen, N. C. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 9: 174-5(June 1966).

34489 THERMAL-NEUTRON DECAY CONSTANTS FOR A SIMPLE SCATTERING KERNEL. Dorning, J. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 176-7(June 1966).

34490 DETERMINATION OF EIGENVALUES OF THE DIFFUSION EQUATION BY VARIATIONAL TECHNIQUES. Bolstad, J. W.; Selengut, D. S. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 9: 192-3(June 1966).

34491 VARIATIONAL ESTIMATES OF DIFFUSION AND EXTRAPOLATION LENGTHS WITH P_1 SCATTERING. Henryson II, H.; Selengut, D. S. (Univ. of California, Berkeley). Trans. Amer. Nucl. Soc., 9: 193-4(June 1966).

34492 UNIFYING APPROACH TO VARIATIONAL FORMULATIONS OF THE TRANSPORT EQUATION. Kaplan, Stanley; Davis, James A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 194(June 1966).

34493 CONTINUITY CONDITIONS FOR A HOMOGENEOUS OR HETEROGENEOUS P_N APPROXIMATION. Davis, James A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 195(June 1966).

34494 VARIATIONAL TECHNIQUES APPLIED TO THE INFINITE-MEDIUM SLOWING DOWN OF NEUTRONS. Hawk, Thomas L.; Fenech, Henri (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 9: 195-6(June 1966).

34495 SPACE ANGLE SYNTHESIS: AN APPROACH TO TRANSPORT APPROXIMATIONS. Kaplan, Stanley; Davis, James A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 196-7(June 1966).

34496 NUMERICAL EXAMPLES OF SPACE ANGLE SYNTHESIS. Natelson, M.; Kaplan, S. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 197-8(June 1966).

34497 USE OF AUXILIARY STORAGE IN NUCLEAR CODES. Worlton, W. J. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 200-1(June 1966).

34498 NUMERICAL SOLUTION OF THE TIME-DEPENDENT MULTIGROUP EQUATIONS. Hansen, K. F.; Andrews II, J. Barclay (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 9: 202-3(June 1966).

34499 ACCURATE EVALUATION OF GROUP SCATTERING MATRICES. O'Reilly, B. D.; Lewis, R. C. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 205-6(June 1966).

34500 SIMPLE CLOSED-FORM EXPRESSIONS FOR THE PSI AND J DOPPLER FUNCTIONS. Krug, H. E.; Olhoeft, J. E. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 206-7(June 1966).

34501 RE-ENTRANT HOLE PERTURBATION IN WATER. Calame, Gerald P.; McGirt, A. F. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 9: 240(June 1966).

34502 THERMAL-NEUTRON SPECTRA IN BERYLLIUM AT ELEVATED TEMPERATURES. Neill, J. M.; Beyster, J. R.; Brouwer, W. (General Atomics, San Diego). Trans. Amer. Nucl. Soc., 9: 240-1(June 1966).

34503 DIFFUSION LENGTH AND NEUTRON TEMPERATURE MEASUREMENTS IN BORON-POISONED WATER AND HEAVY WATER. Baumann, N. P.; Pellarin, D. J. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 9: 241-2(June 1966).

34504 VALIDITY OF THE STATISTICAL TREATMENT OF RESONANCES ABSORPTION IN THE UNRESOLVED RESONANCE REGION. Dyos, M. W.; Stevens, C. A. (General Atomics, San Diego). Trans. Amer. Nucl. Soc., 9: 253(June 1966).

34505 RESONANCE FLUXES AND RESONANCE ABSORPTION IN INTERMEDIATE RESONANCES OF HETEROGENEOUS SYSTEMS. Johnson, B. W.; Connolly, T. J. (Stanford Univ., Calif.). Trans. Amer. Nucl. Soc., 9: 253-5(June 1966).

34506 FIZIKA NEITRONOV NIZKIKH ENERGII. (Physics of Low-Energy Neutrons). Gurevich, I. I.; Tarasov, L. V. Moscow, Izdatel'stvo Nauka, 1966. 607p.

Experiments on the scattering of neutrons of low energies (under 1 ev) permit many problems of solid-state physics, nuclear physics, and elementary-particle physics to be studied. The bases of the physics of low-energy neutrons are presented, and some problems in neutron-scattering theory are examined. The applications of these neutrons in nuclear-physics and solid-state investigations are evaluated. (tr-auth)

34507 VANADIUM PHONON FREQUENCY DISTRIBUTION BY THERMAL NEUTRON INELASTIC SCATTERING. Carpenter, John M.; Vincent, D. H. (Univ. of Michigan, Ann Arbor). 11p. (CONF-650653-15). ORAU. Gmelin, AED-CONF-65-170-28.

From American Physical Society, Summer Meeting, New York.

An experiment is described in which the energy spectrum of neutrons inelastically scattered by polycrystalline vanadium was measured. The neutrons were detected at a scattering angle of 90°, and the target was at room temperature, 300°K ± 5°K. Incident neutron energy was 0.0371 ev. The frequency distribution function was extracted using the relation given by Placzek and Van Hove for one phonon up scattering. (B.G.D.)

34508 PULSED NEUTRON MEASUREMENTS. Chwaszczewski, S.; Rzeszot, T. 41p. (CONF-651123-4). ORAU.

From Conference on Reactor Physics and Engineering, Budapest.

The diffusion parameters of water, organic glass, and epoxy resin were measured using a horizontal channel of EWA and a fast chopper as the neutron source. The decay constants of prompt neutrons were also measured using a pulsed neutron source. The theory behind the experiments is discussed. (G.O.Y.)

34509 KINETIC MODELS FOR FLUIDS AND THEIR APPLICATION TO SLOW NEUTRON SCATTERING. Gibbs, Alan Gregory. Stanford, Calif., Stanford Univ., 1965. 148p.

Thesis.

Incoherent neutron scattering cross sections can be calculated in terms of the space-time correlation function $G_s(\underline{r},t)$ introduced by Van Hove. Some simple kinetic mod-

els are proposed for the calculation of $G_s(\underline{r},t)$ in dense gases and liquids. First, a one-speed random-walk model is introduced and an exact expression obtained for $S_s(\underline{\kappa},\omega)$, the Fourier transform of $G_s(\underline{r},t)$. This quantity is directly related to the scattering cross section for momentum transfer $\hbar\underline{\kappa}$ and energy transfer $\hbar\omega$. Next, a more complex model is introduced in which two types of interactions are considered: hard binary collisions involving the repulsive core of the intermolecular potential, and weak interactions involving the long-range tail. The latter are treated by the Fokker-Planck approximation, and the former by a Boltzmann-like collision integral, which is approximated by a relaxation model of the simple BGK type. The Gaussian approximation (GA) is investigated, and in the context of this model it is found to correspond to treating the hard, as well as the soft, collisions by the Fokker-Planck approximation. The GA introduces errors in $S_s(\underline{\kappa},\omega)$ of about 12 percent at intermediate values of κ with ω near zero; the errors decrease rapidly at small or large κ. When the GA is used, both the present model and the random-walk model predict the same form for $S_s(\underline{\kappa},\omega)$. Thus, random-walk, binary-collision, and Brownian-motion models differ only in their non-Gaussian parts. Finally, the model is generalized to liquid densities by assuming that the basic dynamical entity in a liquid is an atom surrounded by a spherical shell representing the collective effect of its instantaneous near neighbors. This shell is assumed to create a potential well in which the reduced mass of the atom-shell system oscillates harmonically, subject to stochastic forces, while the center of mass of the system is assumed to undergo diffusive motion. Thus, $G_s(\underline{r},t)$ can be written as a convolution of functions representing diffusive and oscillatory behavior. Numerical results show that the oscillatory contributions to $S_s(\underline{\kappa},\omega)$ are small for extreme values of κ, but are very pronounced in the intermediate range. (Dissertation Abstr.)

34510 EFFECTS OF EPITHERMAL NEUTRON FLUX ANISOTROPY ON CADMIUM CORRECTION FACTORS. Powell, James Edward. College Station, Tex., Texas Agricultural and Mechanical Univ., 1965. 121p.

Thesis.

The effects of epithermal neutron flux anisotropy upon the cadmium correction factor F_{cd} were determined both theoretically and experimentally for indium foils in a water medium. Spencer's and Fano's solution of the neutron transport equation was used to determine the values of the magnitude of the vector flux so that the theoretical bare and cadmium-covered activities could be determined. It was shown that this solution gave correct values for the flux only if the weight function was chosen properly. From the theoretical considerations it was found that the experimental data should be plotted as a function of linear combinations of exponential integral functions of the cadmium cover thickness to determine F_{cd}. This fit of the experimental data was designated as an E_n fit. The experimental data were obtained by irradiating cadmium covered indium foils with thicknesses varying from 37 mg/cm^2 to 148 mg/cm^2 at various distances out from a plane source of Pu–Be neutrons. It was found that F_{cd} decreased in value as the distance between the source and detector increased, and that near the source F_{cd} was essentially independent of foil thickness. As the distance between the source and detector increased F_{cd} became more a function of foil thickness. Substantial agreement was obtained between the experimental and theoretical results except near the source. In addition to the E_n fits, logarithmic fits were performed on the experimental data to determine F_{cd}, and the resulting values were compared with the E_n values. The logarithmic values differed from the E_n values by a maximum of 5% near the source, but were almost identical to the E_n values at the farthest positions from the source. (Dissertation Abstr.)

34511 ANALYSIS OF NEUTRON WAVE EXPERIMENTS. Brehm, Richard Lee. Los Angeles, Univ. of California, 1966. 138p.

Thesis.

The analysis of neutron wave-type experiments in homogeneous single-region systems is considered. A general formulation of the dispersion law, which provides the relationship between the dispersion parameters of the system and the frequency of modulation, is given. The dispersion law is examined in various degrees of approximation to determine the general dispersive characteristics of modulated neutron systems as a function of the modulating frequency. Diffusion theory is found to predict accurately the dispersive parameters of modulated systems for frequencies up to approximately 0.1 v Σ radians per second. For increased accuracy at higher frequencies, a simple frequency-dependent transport correction can be applied to the diffusion coefficient. P_1 theory, on the other hand, overemphasizes the frequency dependence and actually provides a poorer approximation than diffusion theory to the true behavior at frequencies above approximately 0.05 v Σ radians per second. Neither diffusion nor P_1 theory gives the correct asymptotic behavior as the frequency approaches infinity. Transport theory indicates that a limiting frequency, called the lower diphase frequency, exists above which source streaming predominates over the scattered neutron flux. Consequently, interpretation of wave experiments in terms of system parameters becomes theoretically impossible. The incorporation of slowing-down effects into the dispersion law is presented in terms of a general time-dependent slowing down kernel. The methods are similar to those used in the analysis of pulsed neutron experiments. The time dependence of the Fermi-age and multigroup kernels is determined and from these dependencies a criterion for the upper frequency limit of validity of each of the slowing-down theories is established. The Fermi-age equations in the P_1 approximation and the consequent age-P_1 dispersion law are derived and examined. For the various theoretical models, the dispersion law is examined for the presence of exceptional frequencies, i.e., pass or stop frequencies. (Dissertation Abstr.)

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Refer also to abstracts 33228, 33405, 33439, 33650, 33718, 33758, 34160, and 35003.

34512 (ANL–7170) EFFECTS OF LEAKAGE UPON EVALUATION OF FAST-REACTOR MULTIGROUP CROSS SECTIONS FOR REFLECTORS. Meneghetti, David (Argonne National Lab., Ill.). Feb. 1966. Contract W-31-109-eng-38. 16p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Group cross sections for aluminum and nickel reflectors, which include effects of energy-dependent leakages into and out of reflector regions, are considered. Leakages are introduced as absorptions in fine-group ELMOE calculations. Iterations are made between coarse-group regional fluxes from criticality calculations and the leakage-modified ELMOE analyses. (auth)

34513 (ANL–7179) PHYSICS DIVISION SUMMARY REPORT, JANUARY–FEBRUARY 1966. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 34p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Research highlights include information on neutron cross sections of ^{10}B at 10 to 500 kev, proton reaction cross sections and strength functions, and a new method for determining charge radii of nuclei. Also included are abstracts or summaries of oral presentations at meetings, abstracts of papers recently accepted for publication, and publication notices of papers appearing in recent books and journals. (B.G.D.)

34514 (CEX–62.13) POST PULSE GAMMA-RADIATION SPECTRUM: OPERATION BREN. Thorngate, J. H.; Loy, E. T. (Oak Ridge National Lab., Tenn.). Dec. 1965. Contract W-7405-eng-26. 118p. Dep. mn. CFSTI $1.25 cy, $0.75 mn.

In order to understand better the gamma-ray field existing after the detonation of a nuclear weapon, a series of gamma-ray spectrum measurements were made as a function of time after a reactor pulse during Operation BREN. Measurements were made with a 3-in.-by-3-in.-NaI(Tl) de-

tector located in a collimator which was aimed alternately at the reactor or 60° away. Although elaborate reduction of the data was not performed, the results indicate the gamma field was produced about equally by the fission products and by nuclear interactions between the delayed neutron and air. (auth)

34515 (CONF-660303-34) GAMMA RAY PRODUCTION CROSS SECTIONS IN (n,n'γ) REACTIONS AND COMPARISON TO SATCHLER THEORY CALCULATIONS. Morgan, I. L.; Mathur, S. C.; Nellis, D. O. (Texas Nuclear Corp., Austin). [1966]. Contract AT(40-1)-3224. 24p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Physical Society, Conference on Neutron Cross Section Technology, Washington, D. C.

A systematic program of experimental measurements of gamma ray production due to (n,n'γ) reactions was developed. The experimental distributions were compared with the predictions of the Satchler theory for twelve nuclei with mass numbers ranging from 24 to 208. The results indicate that the Satchler theory predicts reasonably the anisotropies and the cross sections for nuclei over a wide range of mass numbers, shell structures and incident neutron energies in the range 1 to 5 Mev. Some discrepancies were observed in the region of threshold and may be attributed to cross section fluctuations. The gamma ray production cross sections are required in reactor design, radiation shielding and nuclear theory. However, in many cases, the experimental determination of these cross sections is impractical due to low natural abundance of the nuclear species, low gamma ray yield, and complex gamma ray spectra. In such cases, these cross sections may be calculated on the basis of Satchler theory if the detailed information on the energy levels and their spin and parities is available. Computer programs were developed to perform these calculations. (auth)

34516 (COO-7-0365) EXPERIMENTAL RESULTS ON NUCLEON POLARIZATION PHENOMENA INVOLVING 3-, 4-, AND 5-NUCLEON SYSTEMS. Barschall, H. H. (Wisconsin Univ., Madison). [1965]. Contract AT(11-1)-Gen-7. 42p. (CONF-650928-4). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From International Conference on Polarization Phenomena of Nucleons, Karlsruhe, Ger.

A summary is presented on experimental results on the polarization of nucleons produced in scattering and reactions involving three, four, or five nucleons. The elastic scattering of nucleons by nuclei A = 2, 3, and 4 and the polarization of nucleons produced in the reactions are described. (M.O.W.)

34517 (CU-1019-49) MONTE CARLO CASCADE CALCULATION: PROBLEM OF REFRACTION. Harp, G. D.; Miller, J. M. (Columbia Univ., New York. Coll. of Chemistry). June 1966. Contract AT(30-1)-1019. 8p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A comparison is made of the Monte Carlo cascade calculation of two-body nucleon-nucleon collisions within the nucleus considering refraction and previous calculations not considering refraction and quantal calculations based on an identical nuclear system. The comparisons are made by considering 50- and 160-Mev protons on ^{209}Bi. (B.G.D.)

34518 (INR-680/I/PH) ISOMERIC CROSS SECTION RATIOS FOR ^{58}Ni(n,p)^{58g,58m}Co REACTION INDUCED BY NEUTRONS IN THE 13.2–15.5 Mev ENERGY RANGE. Chojnacki, S.; Decowski, P.; Gierlik, E.; Grochulski, W.; Marcinkowski, A.; Siwek, K.; Sledzinska, I.; Wilhelmi, Z. (Institute of Nuclear Research, Warsaw (Poland). Warsaw Univ. (Poland)). Dec. 1965. 14p. Dep.

The isomeric cross section ratios for the ^{58}Ni(n,p)^{58}Co reaction for the neutron energy range 13.2 to 15.5 Mev were measured. The total cross sections for ^{58}Ni(n,2n)^{57}Ni reaction were obtained independently. (auth)

34519 (INR-683/VI/PH) ANGULAR DISTRIBUTIONS OF SLOW CHARGED SECONDARIES IN THE INTERACTIONS OF 9 Gev NEGATIVE PIONS WITH XENON NUCLEI. Danysz, Marian; Siemiarczuk, Teodor; Zielinski, Przemyslaw (Warsaw Univ. (Poland). Inst. of Experimental Physics. Institute of Nuclear Research, Warsaw (Poland)). Jan. 1966. 8p. Dep.

Range and angle of emission of stopping charged secondaries from interactions of 9 Bev negative pions with xenon nuclei in the xenon bubble chamber was measured. A maximum in the angular distribution at an angle of about 60 degrees with respect to the primary direction is observed. (auth)

34520 (INSJ-97) NUMERICAL DIFFERENTIAL CROSS SECTIONS AND Q VALUES OF THE (p,n) REACTIONS ON ^{52}Cr, ^{55}Mn, ^{56}Fe, ^{58}Ni, ^{80}Se, ^{88}Sr, ^{89}Y, ^{90}Zr AND ^{94}Zr WITH 14.2 Mev PROTONS. Ishizaki, Yoshihide; Saji, Yoshio; Yamaguchi, Hisashi; Aiazawa, Teruo; Fujiwara, Yoshinao; Saheki, Bunzaburo; Yuasa, Kazunori; Okano, Kotoyuki; Yoshimura, Naonori (Institute for Nuclear Study, Tokyo Univ. (Japan)). Apr. 24, 1966. 12p. Dep. mn.

Experimental Q values of the (p,n) reactions for the transitions to the isobaric analogue states and configuration states are presented for ^{52}Cr, ^{55}Mn, ^{56}Fe, ^{58}Ni, ^{80}Se, ^{88}Sr, ^{89}Y, ^{90}Zr, and ^{94}Zr. Numerical values of the differential cross sections of the same reactions on ^{52}Cr, ^{55}Mn, ^{56}Fe, ^{58}Ni, ^{80}Se, and ^{90}Zr are also shown. Targets used in this work were made by sedimentation and deposited onto mylar backings of thickness about 1 micron. (auth)

34521 (JINR-E-2663) EQUILIBRIUM DEFORMATIONS CALCULATED WITH PROJECTED WAVE FUNCTIONS FOR RARE EARTH NUCLEI. Sobiczewski, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 20p. Dep. mn.

The ground state equilibrium deformation and the deformation energy are calculated for even nuclei in the rare-earth region with the help of the projected wave functions. A rather good agreement was obtained between the equilibrium deformations and experiment as well as between the deformation energies and the semi-empirical estimates of these energies. (auth)

34522 (JINR-E-2721) FINE STRUCTURE OF α-SPECTRA IN RARE EARTH REGION. Chumin, V. G.; Gromov, K. Ya.; Makhmudov, B.; Zhelev, Zh. T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1966. 12p. Dep. mn.

The studies of α-spectra of Tb isotopes have resulted in observing the α-decay of ^{149}Tb into a 331-kev ^{145}Eu excited state (E_α = 3644 ± 5 kev) and ^{151}Tb into a 229-kev ^{147}Eu excited state (E_α^- = 3183 ± 5 kev). The α-decay of ^{150}Tb (E_α = 3492 ± 5 kev) was observed. (auth)

34523 (JINR-P-2695) ISSLEDOVANIE REAKTSII ^{238}U + ^{11}B, PRIVODYASHCHEI K CPONTANNO DELYASHCHEMUSYA IZOMERU ^{242}Am. (Investigation of the Reaction ^{238}U + ^{11}B Leading to a Spontaneously Fissionable Isomer ^{242}Am). Gangrskii, Yu. P.; Markov, B. N.; Polikanov, S. M.; Yungklaussen, G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 9p. Dep. mn.

The reaction ^{238}U + ^{11}B leading to the ground (I^-), isomeric (5^-), and spontaneously fissionable states of ^{242}Am was investigated. The excitation functions were obtained for the ground and spontaneously fissionable states. For the 5^- state, the averaged cross section was measured in the energy range of 50 to 68 Mev. The spin of a spontaneously fissionable isomer is estimated. (auth)

34524 (JINR-P-2712) OB ENERGIYAKH OKTUPOL'NYKH SOSLOYANII CHETNA CHETNYKH YADER V OBLASTI 228 ≤ A ≤ 254. (On the Energies of the Octupole States of Even-Even Nuclei in the Energy Region 228 ≤ A ≤ 254. Malov, L. A.; Solovev, V. G.; Fogel, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 6p. Dep. mn.

The energies of the octupole states of even-even deformed nuclei and their structure are investigated using the nuclear model with pairing and octupole interaction. It is shown that the increase of the interaction constant κ

by 10% for $K\pi = 1-,2-$ states as compared to $K\pi = 0-$ improves the agreement between experimental and theoretical data. In particular, the data on octupole states in ^{246}Cm are well explained. (auth)

34525 (KFK-401) RADIOCHEMISCHE BESTIMMUNG DER REICHWEITEN EINIGER SPALTPRODUKTE AUS DER SPALTUNG VON ^{239}Pu MIT THERMISCHEN NEUTRONEN UND DEUTERONEN DER ENERGIEN 12 Mev, 20 Mev, UND 50 Mev. (Radiochemical Determination of the Ranges of Some Fission Products from the Fission of ^{239}Pu with Thermal Neutrons and Deuterons and Energies of 12, 20, and 50 Mev). Rohde, Gerhard (Kernforschungszentrum, Karlsruhe (West Germany)). Feb. 1966. 72p. Dep. mn.

By radiochemical range determinations on some fission fragments from the fission of ^{239}Pu, the change of the energy minimum was investigated as a function of the excitation energy of the fissioning nucleus. These studies were carried out at an excitation energy range between 5 and 40 Mev. At 5 Mev the fission yields from symmetric fission were approximately 3 orders of magnitude below these of asymmetric fission whereas they were equal at 40 Mev. A method was developed by which it was possible to prepare gold foils of uniform thickness. The range of some fission products (^{91}Sr, ^{92}Sr, ^{97}Zr, ^{111}Pd, ^{139}Ba) from the fission of ^{239}Pu by thermal neutron and deuterons at 12 and 20 Mev were determined by the thin target-thin collector method. The ranges of some fission products (^{91}Sr, ^{92}Sr, ^{112}Ag, ^{113}Ag, ^{118}Cd, and ^{139}Ba) from the fission of ^{239}Pu by thermal neutrons and deuterons at 20 and 50 Mev were determined by the thick target-thick collector method. An evaluation was made of the excitation energy and the frequency of the intermediate nuclei and fission nuclei in the fission by neutrons of varying energies. The most probable charge of the fission fragments, and the number of evaporated neutrons could then be calculated. From the ranges, the values of the total kinetic energies were calculated and the results were compared with previous results. The comparison showed that the value of the total kinetic energy in the area of mass ratios from 0.8 to 1.3 (asymmetric fission) are independent of the excitation energy of the fissioning nucleus. The value of the total kinetic energy in the area of symmetric fission increases by about 8 Mev from 5 to 20 Mev excitation energy and remains constant thereafter. It could be shown that these results are in good agreement with the hypothesis of the 2 independent fission types for symmetric and asymmetric fission. The usual assumption for the distribution of the excitation energy of the fissioning nucleus on the primary fission fragments in the ratio of their nucleon numbers appears incorrect. This could be evaluated from the number of evaporated neutrons in the area of symmetric fission. (J.S.R.)

34526 (NP-16125) MEASUREMENT OF THE $^{6}Li(n,\alpha)$ AND $^{10}B(n,\alpha)$ CROSS SECTIONS BY THE SHELL TRANSMISSION METHOD. Cox, S. A.; Pontet, R. F. (Atomic Weapons Research Establishment, Aldermaston (England)). [1965]. 31p. Dep. mn.

The spherical shell transmission method was used to measure the total neutron absorption cross sections for ^{10}B from 10.7 to 247 kev and for ^{6}Li from 10.7 to 102 kev. For ^{6}Li the absorption cross section could be equated directly to the (n,α) cross section. In the case of ^{10}B, the absorption cross section may contain a weak component due to the (n,t) reaction in addition to the (n,α) reaction. The $^{10}B(n,\alpha)$ measurements near 10 kev are in good agreement with a 1/v extrapolation from the thermal cross section. The ^{6}Li (n,α) results near 10 kev are ~30% higher than a 1/v extrapolation from the thermal cross section and are in agreement with some earlier work but are in disagreement with recent measurements of Bergman and Shapiro and of Schwarz, Stromberg, and Bergstrom both of which are consistent with a 1/v extrapolation. (auth)

34527 (RLO-1388B-6) CHARGE DEPENDENCE OF NUCLEAR FORCES. Henley, E. M. (Washington Univ., Seattle). [1965]. Contract AT(45-1)-1725. 35p. (CONF-660306-10). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From American Physical Society, Conference on Isobaric Spin, Tallahassee.

The present status of the small deviations from charge independence and charge symmetry is reviewed. The discussion is almost completely restricted to low-energy nuclear physics, and primarily to N-N system. (M.O.W.)

34528 (UJV-1571) LEVEL STRUCTURE OF OXYGEN ISOTOPES IN SU_3 SCHEME. Trlifaj, L.; Gmitro, M.; Sotona, M. (Ustav Jaderneho Vyzkumu, Ceskoslovenska Akademie Ved, Rez). 1966. 31p. Dep. mn.

The lowest ^{20}O and ^{18}O levels are calculated in the L-S coupling using the SU(3) classification. The residual interaction is taken as a mixture of two-body Gaussian potentials and spin-orbit force. After fitting the energy spectrum, the spectroscopic factors of the reaction $^{18}O(t,p)^{20}O$ and E2 transition probabilities are calculated. The overall agreement with the experiment is obtained. (auth)

34529 (UR-3591-2) NUCLEAR REACTION MECHANISMS. Progress Report, September 1, 1965-May 1, 1966. Blann, Marshall (Rochester Univ., N. Y. Dept. of Chemistry). Contract AT(30-1)-3591. 42p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Excitation functions and recoil ranges were measured for deuteron reactions on nickel-58, lithium-6 reactions on iron-54, helium-4 reactions on vanadium-51, zirconium-90, gold-197, and nickel-58, and alpha reactions on cobalt-59. These reactions were all in the 0- to 100-Mev range. The energy levels of iron-55 were also investigated. (M.O.W.)

34530 (CONF-660107-46) (d, ^{3}He) STUDIES ON ^{89}Y AND ^{90}Zr. Shreve, D. C.; Kavaloski, C. D.; Lilley, J. S.; Stein, Nelson (Washington Univ., Seattle). [1964]. Contract AT(45-1)-1725. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Physical Society Meeting, New York.

The reactions $^{90}Zr(d,He\text{-}3)^{89}Y$ and $^{89}Y(d,He\text{-}3)^{88}Sr$ were studied using 21-Mev deuterons. These reactions were studied in order to investigate the single-particle nature of the low-lying states of ^{89}Y and ^{88}Sr. Angular distribution measurements were made. (M.O.W.)

34531 CONSIDERATION OF RESONANCE STRUCTURE OF FERTILE AND FISSION NUCLEI IN THE CALCULATIONS OF FAST AND INTERMEDIATE REACTORS. Pucker, N. (Univ., Graz). Acta Phys. Austr., 21: 283-9(1966). (In German).

The self-screening properties of the resonances of heavy nuclei can be represented simply by polynomial functions. Through the connected separation and through the potential cross section, energy, and temperature dependence, a representation can be given for the group cross section that depends only on the potential cross section and on the group constants. The cross sections for ^{238}U and for ^{239}Pu in the cases E = 100 ev and E = 1050 ev are shown. The group cross section value of the two lowest groups of the 16-group law of Yiftah, Okrent, and Moldauer is compared with the present calculations for ^{238}U. (J.S.R.)

34532 DESCRIPTION OF THE QUASI-MOLECULAR STATES BY AN INDEPENDENT-PARTICLE MODEL. Demeur, M.; Reidemeister, G. Ann. Phys. (Paris), 1: 181-7(1966). (In French).

The energy spectrum of a particle bound by the potential $W = V + B\bar{s}$. $(\bar{v} \times \text{grad } V)$ where $V = \frac{1}{2} m\omega^2 \{x^2 + y^2 + (|z| - z_0)^2\}$ was calculated as a function of deformation parameter z_0. Values 0 and ∞ of z_0 describe respectively a spherical nucleus and two identical spherical nuclei, the total number of nucleons remaining the same. The energy spectrum was used to build an independent particle model describing dumb-bell deformed nuclei. One of the results is the occurrence of a bound orbital $\Omega^{\pi} = \frac{1}{2}^{+}$ suggesting the existence of a $\frac{1}{2}^{+}$ state in ^{9}Be and also favorable to the formation of quasi-molecular states in systems like $^{10}B-^{10}B$, $^{11}B-^{11}B$, and $^{12}C-^{12}C$. (auth)

34533 DETERMINATION OF PROBABILITIES OF SPONTANEOUS FISSION OF ^{233}U, ^{235}U, AND ^{243}Am. Alexandrov, B. M.; Krivokhatskii, L. S.; Malkin, L. Z.; Petrzhak, K. A. At. Energ. (USSR), 20: 315-17(Apr. 1966). (In Russian).

The spontaneous fission times for ^{243}Am, ^{233}U, and ^{235}U were measured using vitreous plates. An attempt was made to produce systematic data according to the spontaneous fission of odd-even and even-odd nuclei. (G.O.Y.)

34534 β-γ COINCIDENCE METHOD FOR ANALYZING COMPLEX γ SPECTRA. May, R. (Justus Liebig Univ., Giessen, Ger.). Atomkernenergie, 11: 302-6(July-Aug. 1966). (In German).

A β-γ-coincidence method for analyzing complex γ spectra is described. It can be used to estimate the relative intensities of photopeaks with almost equal energies, even if the energy differences are less than the resolution energy of the detectors employed. Primarily, the method is defined for studying hot particles. Despite the intensity loss by coincidence circuit, the photo maximum range (at 760 kev) is higher by one order of magnitude than in the case of measurements with a conventional Ge(Li)-semiconductor counter, thus resulting in a much lower limit of detection. If for instance the ratio of zirconium-95 to niobium-95 is to be measured for the purpose of determining a sample's age to a degree of accuracy of approximately 3.5%, then an activity of merely $8 \cdot 10^{-10}$ Ci is required at a measuring time of 8 hours. (auth)

34535 INTERNAL CONVERSION STUDIES IN THE ^{140}La DECAY. El-Nesr, M. S.; El-Aassar, M. R.; El-Sayad, G. M.; Migahed, M. (Atomic Energy Establishment, Cairo). Atomkernenergie, 11: 307-15(July-Aug. 1966).

The electron conversion spectrum associated with the decay of ^{140}La to ^{140}Ce has been studied using a high resolution double focusing beta-ray spectrometers. A scintillation spectrometer with a RIDL-transistorized 400 channel analyzer has been used for the investigation of the hard gamma rays. Thirty-two new gamma rays of energies 60.28, 63.43, 100.01, 111.47, 120.00, 148.50, 159.41, 190.93, 200.08, 204.87, 244.51, 267.88, 273.69, 326.18, 331.02, 337.50, 353.37, 374.81, 375.65, 428.62, 482.00, 542.43, 805.74, 824.51, 838.38, 932.98, 956.02, 969.77, 980.19, 1016.20, 1040.31, and 1054.65 kev were found from the internal conversion measurements. A complete set of energy sum was computed in order to survey the possibilities of cascade-cross over combinations. Multipolarity information has been obtained for 35 transitions by comparing the observed internal conversion line intensity ratios with theoretical values calculated by Sliv and Band. New information about the mixing ratios for some of the gamma-transitions has been deduced from the measured K/L ratios. The possible existence of 8 new levels at 205, 353, 1260, 1889, 2026, 2184, 2371 and 2585 kev is proposed with spin and parity: (3−), (0+), (1−), (0+), (2+), (3−) and (4+) respectively. Two additional new levels are proposed at energies 2900 and 3100 kev. The spins and parities of the excited states in ^{140}Ce are assigned on the basis of internal conversion electron measurements. On the basis of precise energy data combined with earlier reported coincidence results, a decay scheme involving 61 transitions is suggested. This decay scheme disagrees in several aspects with those previously proposed. (auth)

34536 STUDY OF GAMMA RADIATIONS FROM ^{134}Cs BY THE EXTERNAL CONVERSION METHOD. Bashandy, E.; El-Haliem, A. Abd (Atomic Energy Establishment, Cairo). Atomkernenergie, 11: 316-20(July-Aug. 1966).

The photoline spectrum from the gamma rays following the decay of 2.3 y ^{134}Cs has been studied with a double focusing beta-ray spectrometer, using a 2.9 mg/^{2}cm uranium converter. The resulting momentum resolution was 0.2 to 0.7% depending on energy. A total of twenty-nine gamma transitions have been observed. In addition to the already established gamma rays, sixteen new gamma transitions were found. Direct ground state transitions of energies, 1.40, 1.64, 1.77, 1.84 and 1.97 Mev were observed for the first time. The relative gamma-ray intensities have been determined from the external conversion spectrum applying the corrections for the angular dependence of the photoelectric process. A modification of the previously reported scheme of levels is proposed including four new excited states of energies 923, 1062, 1374, and 1845 kev. The experimentally obtained data are compared with the predictions of Davydov-Filippov theory for axially symmetric even nuclei. (auth)

34537 INVESTIGATION OF THE EXISTENCE OF NUCLEON-STABLE ^4H IN THE $^7Li(n,\alpha)^4H$ REACTION AT 14.7 Mev. Csikai, Gyula; Nagy, Sandor. ATOMKI (Atommag Kut. Intez.) Kozlem., Mellek., 8: 3-7(1966). (In Hungarian).

The existence of ^4H not decaying by nucleon emission was investigated in the $^7Li(n,\alpha)^4H$ reaction, using a cloud chamber. The sensitivity of the method is independent of the half life of the $^4H \rightarrow {}^4He$ beta decay. The evaluation of ~2000 photographs gave no event which would prove the existence of ^4H. An upper limit of $\sigma < 2.2$ mb was obtained for the cross section of the reaction $^7Li(n,\alpha)^4H$. (auth)

34538 MEASUREMENT OF THE TOTAL CROSS SECTION OF THE $^{23}Na(d,p)^{24}Na$ REACTION AT 400 TO 700 kev. Schlenk, Balint; Mesko, Laszlo. ATOMKI (Atommag Kut. Intez.) Kozlem., Mellek., 8: 9-16(1966). (In Hungarian).

The total cross section of the $^{23}Na(d,p)^{24}Na$ reaction for deuteron energies from 400 to 700 kev was measured using the activation method. The thickness of the thin NaF target was determined by measuring the broadening of the 340-kev resonance line in the $^{19}F(p,\alpha\gamma)$ reaction. The absolute cross section was measured at 632 kev bombarding energy, and the other points of the curve were obtained by normalization. The total cross section curve as a function of energy is of exponential character, and resonances or fluctuations for the given accuracy of the measurement are not observed. (auth)

34539 INDUCED RADIATION OF GAMMA QUANTA AND TWO-PHOTON PHOTOEFFECT. Kamenov, P.; Bonchev, T. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 18: 1103-6(1965).

The experimental observation of induced radiated gamma quanta and the resulting photoeffect are considered. The apparatus, conditions necessary for observation of the phenomenon, and the characteristics of the specific isotope which may be expected to bring about the induced radiation are indicated. Possible experimental results are also discussed. (J.F.P.)

34540 SHELL-MODEL ENERGY CALCULATION FOR ^6Li. Gabrakov, S. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 19: 21-3(1966).

In order to explain the disagreement with the experimental data of the charge density of lithium-6 calculated from the shell model the hypothesis is proposed that not all nucleons in the nucleus are in the same potential well. In the case of lithium-6 the 1s and 1p nucleons are in wells with different parameters. The total energy of lithium-6 is calculated with the above assumption, and a correlation is found between the parameters at a minimum value of energy. Curves are given showing the total energy as a function of one of the parameters. (J.F.P.)

34541 THE CONVERSION ELECTRON SPECTRA EMITTED DURING THE TRANSMUTATION OF ^{227}Th (RdAc) TO ^{223}Ra (AcX). STUDY OF THE RADIATIONS WITH ENERGY ABOVE 200 kev. Briancon, Chantal; Vieu, Charles (CNRS, Orsay, France). Compt. Rend., Ser. B, 262: 1306-8(May 9, 19666). (In French).

With the aid of semicircular magnetic spectrographs with photographic detection, the conversion electron spectra emitted in the transmutation $^{227}Th \rightarrow {}^{223}Ra$ were studied. The γ rays observed with energies higher than 200 kev are tabulated. (tr-auth)

34542 STUDY OF THE MOBILITY OF RADIOACTIVE IONS FORMED ON RECOIL ATOMS COMING FROM THE DECAY OF THORON IN AIR AND DIFFERENT GASES. Fontan, Jacques; Billard, Francois; Blanc, Daniel; Bricard,

Jean; Huertas, Marie-Louise; Marty, Anne-Marie (Univ., Paris). Compt. Rend., Ser. B, 262: 1315-17(May 9, 1966). (In French).

The mobility of radioactive ions formed on recoil atoms coming from the decay of thoron in air and in different gases at atmospheric pressure was measured. In this region between 4 and 0.1 $cm^2\ V^{-1}\ sec^{-1}$, there exist three different ion categories whose mobilities depend on the nature of the gas. In helium the existence of only one category could be established and its mobility is of the order of 3.5 $cm^2\ V^{-1}\ sec^{-1}$. (tr-auth)

34543 EVIDENCE OF THE ELECTROMAGNETIC DEEXCITATION OF THE FIRST LEVEL OF ^{48}Ca. Gorodetzky, Serge; Britz, Jean; Chevallier, Pierre; Drouin, Robert; Rabin, Bernard; Sutter, Gilbert (Institut de Recherches Nucleaires, Strasbourg). Compt. Rend., Ser. B, 262: 1455-8(June 1, 1966). (In French).

An attempt was made to remove definitely the possibility $J^\pi = 0^+$ for the first level of ^{48}Ca at 3.825 Mev by studying its electromagnetic decay. The reaction $^{48}Ca(p,p')$ was used. The excitation curve for proton energies between 4.5 and 6.6 Mev was measured and the presence of two resonances at 5.599 ± 0.06 and 6.073 ± 0.006 Mev was established. A γ ray of 3.834 ± 0.008 Mev was detected at the second resonance. The attribution of this γ ray to the first level of ^{48}Ca was verified by simultaneous measurement of the excitation curve of this resonance in protons, in γ, and in proton-γ coincidences. No level $J^\pi = 0^+$ was observed in ^{48}Ca. (J.S.R.)

34544 REACTIONS (d,d) AND (d,p) ON ^{12}C. Lambert, Michel; Dumazet, Gerard; Benedetti, Charles; Gresillon, Dominique (Institut d'Etudes Nucleaire, Alger, France). Compt. Rend., Ser. B, 262: 1459-61(June 1, 1966). (In French).

The excitation curves relative to the reaction $^{12}C(d,d)^{12}C$, $^{12}C(d,p_0)^{13}C$, and $^{12}C(d,p_1)^{13}C$ were traced for incident deuterons with energy between 1 and 2 Mev and for 8 angles between $\theta_{CM} = 48°52'$ and $\theta_{CM} = 161°59'$. (tr-auth)

34545 EFFECT OF THE CHANGING STRUCTURE OF THE NUCLEUS ON THE PROBABILITY OF β-DECAY. Berlovich, E. E.; Novikov, Yu. N. (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR, 165: 1026-8(Dec. 11, 1965). (In Russian).

Following up the authors' earlier finding that the electromagnetic and level properties of odd-proton nuclei in the transition range of Eu and Pm isotopes point to small equilibrium deformations, it is shown that β transitions between these odd-proton and the neighboring odd-neutron spherical nuclei are characterized by high log ft values; this is due to changes in the shape of the nucleus during the β transition. From a tabulation of forbidden transitions with ΔI = 1 it is found that the value of log ft in the transition range exceeds by 2 to 3 units the average value of log ft in other ranges. Absence of β transitions in the range $^{149}Nd \rightarrow {}^{149}Pm$, $^{149}Pm \rightarrow {}^{149}Sm$, signifies that the log ft values are very high (low-intensity transitions) because competing β transitions at ΔI = 0 with high log ft value were observed. The relatively high values of log ft for the $^{145}Eu \rightarrow {}^{145}Sm$, $^{141}Ce \rightarrow {}^{141}Pr$, $^{143}Pm \rightarrow {}^{143}Nd$ transitions are probably due to the fact that each of the nuclei has a filled neutron shell N = 82. Data are tabulated for deformed nuclei, such as ^{103}Rh, ^{109}Ag, ^{75}As and β transitions in the second transition range, in which the shape of the nucleus may be changed. (TTT)

34546 MEASUREMENT OF THE EFFECTIVE RESONANCE INTEGRAL OF A NATURAL URANIUM METAL CLUSTER CONTAINING MODERATING COOLANTS. Arcipiani, B.; Boeuf, A.; Haemers, L.; Tassan, S. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan), 13: 285-90(1966).

An activation analysis is presented of the ^{238}U resonance neutron capture integral of a close-packed 19-rod natural U cluster, containing various moderating coolants. The features of the experimental method are presented in some detail, and the results of the experiment are compared with calculated values. A short analysis of the data puts into evidence the limits of validity for this kind of experiments. (auth)

34547 NUCLEAR LEVEL WIDTHS IN THE CONTINUUM REGION. Corti, M.; Marcazzan, M. G.; Colli, L. Milazzo; Milazzo, M. (Univ., Milan). Energ. Nucl. (Milan), 13: 312-17(1966).

The experimental values of the nuclear level widths Γ, obtained from the analysis of the statistical fluctuations in the excitation curve of nuclear reactions, are collected and compared with the predictions of the statistical evaporation theory. A new method of extracting the Γ value is suggested and applied to the case of $^{35}Cl(d,p)^{36}Cl$. (auth)

34548 LAGRANGIAN AND HAMILTONIAN FORMALISM FOR NON CONSERVATIVE FORCES. Sona, P. G. (CISE, Milan). Energ. Nucl. (Milan), 13: 318-22(1966).

The application of lagrangian and hamiltonian formalism to nonconservative forces is considered. A Schroedinger equation is derived for a simple example in view of a possible foundation of an optical model for inelastic scattering. The main difficulty in the physical interpretation seems originated by the lack of the existence of a simple continuity equation. (auth)

34549 A METHOD FOR THE CALIBRATION OF ^{103m}Rh AND THE ABSOLUTE CROSS SECTION FOR THE REACTION $^{103}Rh(n,n')^{103m}Rh$ with 14.2-Mev NEUTRONS. Nagel, W.; Aten, A. H. W. Jr. (Instituut voor Kernphysisch Onderzoek, Amsterdam). J. Nucl. Energy: Pt. A and B, 20: 475-7(June 1966).

Calibration of ^{103m}Rh as a fast-neutron detector was carried out by making use of the equilibrium between the parent ^{103}Ru and the daughter ^{103m}Rh and recording the count rates due to the Compton gamma rays from ^{103}Ru and the x rays from ^{103}Ru and ^{103m}Rh. The cross section for the $^{103}Rh(n,n')^{103m}Rh$ reaction was measured by activation at 14.2 Mev; a value of 508 ± 50 mb was found. (M.J.T.)

34550 THE PREPARATION OF CARRIER-FREE ^{232}U AND THE ESTIMATION OF VARIOUS NUCLIDES PRODUCED BY THE NEUTRON IRRADIATION OF ^{231}Pa. Sakanoue, Masanobu; Komura, Kazuhisa (Kanazawa Univ., Japan). J. Nucl. Sci. Technol. (Tokyo), 3: 249-55(June 1966).

For use as uranium tracer, ^{232}U was prepared by neutron irradiation of ^{231}Pa in JRR-2. Carrier-free ^{232}U produced in the target material was separated by solvent extraction with TIOA in an HCl-HF system, and purified by the anion exchange method using Dowex 1 × 8. The radiochemical purity of ^{232}U was examined by means of alpha and gamma spectrometry, and it was confirmed that the ^{232}U obtained by this method was of sufficiently pure quality as uranium tracer to be used in very low level determination of uranium isotopes in natural samples. Furthermore, with the view to efficient production and radiochemical purification of ^{232}U, the relative quantities of various by-product nuclides were estimated. (auth)

34551 A REMARK ON THE DOPPLER BROADENING OF NEUTRON RESONANCE. Kadotani, Hiroyuki; Furuhashi, Akira (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 3: 257-8(June 1966).

Two modifications to previous formulations of the resonance absorption of neutrons by chemically bound nuclei are proposed, which takes into account the difference between the neutron mass and the reduced mass, and a correction to the mass of the absorbing nucleus. It is shown that the basic equation for the resonance absorption, together with the modified scattering law, provides an exact expression for the Doppler-broadened resonance. (L.B.S.)

34552 MOESSBAUER EFFECT STUDIES OF THE 46.48-kev LEVEL OF ^{183}W. Shikazono, Naomoto; Takekoshi, Hidekuni; Shoji, Tokio (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Jap., 21: 829-33(May 1966).

The recoil-free resonant absorption spectra of the 46.48-

kev gamma rays from ^{183}W were studied with tungsten metal, WO_3 powder and a single crystal of WO_3. The source used was metallic tantalum irradiated with thermal neutrons. The natural line width obtained from the absorption spectra with tungsten metal absorbers is $\Gamma_{nat} = (2.88 \pm 0.06) \times 10^{-6}$ ev. The mixing ratio E2/M1 is estimated at 0.5%. From the absorption spectra with the absorbers of WO_3 powder and WO_3 single crystal, the quadrupole coupling constant is estimated at $-3.0 \pm 0.3 \times 10^{-6}$ ev. This value is compared with the known value of the coupling constant for ^{182}W in WO_3. The ratio of the quadrupole moment of the first excited $3/2^-$ state of ^{183}W to the first excited 2^+ state of ^{182}W is obtained. (auth)

34553 LEVELS OF ^{27}Al. Wakatsuki, Tetsuo; Hirao, Yasuo; Miura, Iwao; Shimizu, Akira (Osaka Univ.). J. Phys. Soc. Jap., 21: 834-41(May 1966).

Coincidences between gamma rays and scattered protons were taken using $^{27}Al(p,p'\gamma)$ reaction at a proton energy of 5.7 Mev. Protons were detected by a surface-barrier solid-state detector at right angles to the beam. Gamma rays were measured by a 12.7 cm × 10.2 cm NaI(Tl) crystal placed at right angles to the beam. From the coincident gamma spectra, gamma branching ratios were calculated for excited levels below 4.504 Mev. Spins of $3/2$ and $5/2$ are suggested for the 3.951 and 4.50 Mev level respectively from these results. A rotational model description of the ^{27}Al nucleus is discussed. (auth)

34554 SHELL EFFECTS IN THE CROSS SECTION OF THE REACTION $^{67}Zn(\gamma,p)$. Ivanchenko, V. G.; Ratner, B. S. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 3: 296-8(June 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 3: 452-5(June 1, 1966).

An attempt was made to obtain more accurate data with respect to the connection between the photoproton cross section and the shell structure of the nucleus using ^{67}Zn. The yield of the reaction $^{67}Zn(\gamma,p)^{66}Cu$ was measured as a function of the maximum γ-quantum energy of the 30-Mev synchrotron by recording the β activity of the final ^{66}Cu nucleus with two end-window counters. (M.H.R.)

34555 EXCITED STATES OF THE ^4He NUCLEUS. Dzhibuti, R. I.; Mamasakhlisov, V. I.; Macharadze, T. S. (Tbilisi State Univ., USSR. Inst. of Physics, Academy of Sciences, Georgian SSR). JETP Lett. (USSR)(Engl. Transl.), 3: 298-9(June 1, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 3: 456-7(June 1, 1966).

Some circumstances are noted which allow the levels of ^4He to be regarded as rotational ones. It is further pointed out that inasmuch as the second O^+ level lies quite high (20 Mev), the probability is that the excitation is single-particle and possibly corresponds to the formation of a 3 + 1 cluster configuration. The closeness of the levels observed in the ^4He nucleus offers evidence in favor of a collective nature for these levels. (M.H.R.)

34556 MOESSBAUER SPECTROMETRY. Meisel, W.; Jacob, J. (Akademiewerkstaetten fuer Forschungsbedarf, Deutsche Akademie der Wissenschaften, Berlin. VEB Carl Zeiss, Jena, Ger.). Kernenergie, 9: 113-19(Apr. 1966). (In German).

The Mössbauer effect and Mössbauer spectra are discussed in a general survey of Mössbauer spectrometry and some of its applications. (G.O.Y.)

34557 TRITON REACTIONS WITH ^{30}Si. PART I. THE NUCLEAR REACTION $^{30}Si(t,p)^{32}Si$. Jantsch, K. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 9: 127-32(Apr. 1966). (In German).

The production of ^{32}Si by secondary tritons of the reaction $^6Li(n,\alpha)T$ was investigated. The targets used were Li–Si alloys of various compositions and Li_2SiO_3. The quantitative determination of ^{32}Si was measured by monitoring the activity of its daughter nucleus ^{32}P. The experimental cross section obtained in good agreement with the theoretical value. The cross sections for the reactions $^{31}Si(n,\gamma)^{32}Si$ and $^{32}P(n,p)^{32}Si$ were also determined. The impossibility of using these reactions for the production of microcurie amounts of ^{32}Si was discussed. (G.O.Y.)

34558 STUDY OF THE DEPENDENCE OF THE ISOMERIC CROSS SECTIONS OF NUCLEI, RESULTING FROM IRRADIATION BY THE γ RAYS OF ^{60}Co, ON THE EXPERIMENTAL CONDITIONS. Veres, Arpad (National Atomic Energy Commission, Budapest). Magyar Fiz. Foly., 14: 143-59(1966). (In Hungarian).

The nuclear photoelectric effect, represented by the $A(\gamma,\gamma')A^*$ reaction—whereby A designates an atom interacting with a γ quantum and A^* is an isomer of the same atom—results in the formation of an excited level, lying above the metastable level, from which the nucleus reaches either directly or through cascade transitions, passing through the metastable, the ground state. The effect of experimental conditions on the cross section of this reaction was analyzed, calculating the correlations between the commonly used form factors of ^{60}Co sources; the effect of thickness of the absorbent and target layers and the partial cross sections was also taken into consideration. The shapes considered included sphere, cylinder, disc and cylinder, comparing theoretical curves and experimental measurements with Pb, Fe, Al, and graphite absorbents. The effect of the condition s was analyzed by decomposing the cross section into 4 components: $\sigma = \sigma_1 + \sigma_2 + \sigma_3 + \sigma_4$, whereby σ_1 indicates the scattering in the source material, σ_2 in the material between the source and the target, σ_3 in the shield, and σ_4 in the target. These components may be easily calculated, except for σ_3 which is variable because of the multiple scattering and variations of the shielding wall thickness; this value must be determined experimentally. (TTT)

34559 MEASUREMENT OF THE ABSOLUTE DISINTEGRATION RATE OF ^{99m}Tc. Goodier, I. W.; Williams, A. (National Physical Lab., Teddington, Eng.). Nature, 210: 614-15(May 7, 1966).

An absolute disintegration rate of ^{99m}Tc measured by the $4\pi\beta$-γ coincidence technique is discussed. (B.G.D.)

34560 BETA ACTIVITY OF ^{40}K IN NATURAL ISOTOPE MIXTURES. Feuerhake, I.; Hinzpeter, A. (Technische Hochschule, Hanover). Naturwissenschaften, 53: 272-3(1966). (In German).

The β activity of ^{40}K was measured using KCl in a gel scintillator. A value of 27.9 ± 0.3 cps/g K_{nat} was found and compared with previous results. The advantages of the method used are discussed. A β decay constant of $\lambda_\beta = (4.85 \pm 0.09) \times 10^{-10}$ y^{-1} was determined. (J.S.R.)

34561 ENERGY LEVELS OF ^{237}Np. I. THE ALPHA DECAY OF ^{241}Am. Lederer, C. M.; Poggenburg, J. K.; Asaro, F.; Rasmussen, J. O.; Perlman, I. (Univ. of California, Berkeley). Nucl. Phys., 84: 481-504(1966). (UCRL-16414).

The γ ray spectrum of ^{241}Am from 80 to 850 kev was studied with a high resolution semi-conductor γ ray spectrometer; α-γ- and α-electron-coincidence spectra were studied with semi-conductor and scintillation detectors. From these data and previous results, a decay scheme is constructed. Theoretical α-intensity calculations aided in establishing the decay scheme. Nilsson assignments $5/2^+[642]$, $5/2^-[523]$ and $1/2^+[400]$ for rotational bands based on levels at 0, 59.54 and 332.36 kev are confirmed. A new $1/2^-[530]$ band, whose lowest member is the wellknown 267.54 kev $3/2^-$ level, is positively identified, and $K = 5/2^-$ beta-vibrational band is established. The latter band decays primarily by M1 transitions, in violation of the vibrational selection rule. A previously unreported level at 770 kev with a probable $I^\pi = 1/2^+$ assignment is also of probable vibrational character. A brief study of ^{243}Am decay reveals a similar structure for ^{239}Np. (auth)

34562 ENERGY LEVELS OF ^{237}Np. II. HIGH-RESOLUTION STUDY OF TRANSITIONS IN THE DECAY OF ^{237}U. Yamazaki, T.; Hollander, J. M. (Univ. of California, Berkeley). Nucl. Phys., 84: 505-33(1966). (UCRL-16577).

The conversion-electron and gamma spectra from the

decay of ^{237}U were studied using a high-resolution iron-free spectrometer and solid-state gamma spectrometers. In addition to the previously known transitions, several previously unreported lines were observed and fitted into the ^{237}Np level scheme. Absolute conversion coefficients for most of the transitions were determined. The presence of the previously undiscovered level at 281.35 kev, confirmed by the observation of a very strong 13.81-kev, M1-E2 transition and a weak 221.8-kev crossover transition, establishes that the 267.54-kev, $\frac{3}{2}^-$ level is the lowest member of a $K = \frac{1}{2}^-$ band. (auth)

34563 NANOSECOND LIFETIME MEASUREMENTS ON HIGH-ENERGY LEVELS OF ^{182}W. Meiling, W.; Stary, F. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., 84: 534-44(1966). (In German).

The lifetimes of high-energy levels in ^{182}W were measured to be $T_{½}$(1374 kev) ≦ 0.3 nsec and $T_{½}$(1554 kev) = 1.30 ± 0.07 nsec. These values are in disagreement with previous results. For the lifetime of the 1290 kev level, a modified value of $T_{½}$(1290 kev) = 1.00 ± 0.05 nsec is suggested. The measurements were performed with a multi-parameter time analyser using a third scintillation detector for better energy selection. (auth)

34564 A STUDY OF THE HARTREE-FOCK APPROXIMATION AS APPLIED TO FINITE NUCLEI. Davies, K. T. R. (Oak Ridge National Lab., Tenn.); Krieger, S. J.; Baranger, M. Nucl. Phys., 84: 545-68(1966). (ORNL-P-2079).

Wave functions, energy levels, binding energies, and density distributions were calculated for ^{40}Ca, ^{12}C, ^{16}O, ^{28}Si, ^{60}Zn, and ^{80}Zr using the Hartree-Fock approximation with a velocity-dependent two-body force that acts in relative s-states only. The results are in rough agreement with experimental observations. The nonlocal Hartree-Fock potential is discussed. (D.C.W.)

34565 THE DECAY OF 37.5-min ^{164m}Ho. Joergensen, M. H.; Nielsen, O. B.; Skilbreid, O. (Univ. of Copenhagen). Nucl. Phys., 84: 569-76(1966).

It is shown that a 37.5 min activity of ^{164}Ho belongs to a 139-kev state, whereas the ground state has a half life of 29 ± 2 min. The 139-kev level probably has spin 6^- and decays through the 3^+, 2^+, and 1^+ members of the $K = 1^+$ ground-state rotational band by transitions of 45.9 kev (E3), 56.1 kev (M1), and 37.0 kev (M1). This decay scheme is analogous to that of the 68-min ^{162}Ho state at 106 kev. The log ft values for the β^--branches from the ^{164}Ho ground state to the 0^+ and 2^+ states of the ^{164}Er ground-state rotational band are 5.5 ± 0.2 and 5.8 ± 0.2, whereas log ft ≦ 4.8 for the transition to the ^{164}Dy ground state. Based on these allowed unhindered β^- and electron-capture transitions, single-particle assignments can be made for the isomeric state as well as for the ground state of ^{164}Ho. The difference in ft values for the transitions to the two even daughter nuclei is interpreted as an indication of individual behavior of the single particles in the pair scattering process. (auth)

34566 SPINS AND PARITIES OF HIGHER EXCITED STATES IN ^{188}Os. Bashandy, E.; Hanna, S. G. (Atomic Energy Establishment, Cairo). Nucl. Phys., 84: 577-85 (1966).

The energy level spectrum of ^{188}Os excited in the decay of ^{188}Re was investigated by means of a high-resolution, double-focusing beta spectrometer. The internal K-conversion coefficients of the 209, 288, 673, 828, and 931 kev levels were determined by the internal-external conversion method. The ratios of conversion and photon intensities were normalized with respect to the 633-kev E2 transition in ^{188}Os. The K-conversion coefficients were obtained from the known internal conversion coefficient of this transition. The multipolarity assignments of these transitions were studied on the basis of the conversion coefficients. These measurements together with the previously known assigned levels establish the spins and parities 0^+, 3^-, 2^-, 2^+, and 1^+ for the 1086, 1306, 1461, 1750, and 1958 kev levels in ^{188}Os. (auth)

34567 THREE-ALPHA-PARTICLE RESONANCES VIA THE FADEEV EQUATION. Duck, Ian (Rice Univ., Houston, Tex.). Nucl. Phys., 84: 586-94(1966). (TID-22629).

The Fadeev equation with a separable two-particle scattering amplitude is used to search for stationary states of the three-alpha-particle system. With a two-particle scattering amplitude consisting of an S-wave resonance, a single low-energy resonance is found which can be driven to negative energy only by using unreasonable off-energy-shell dependence of the two-particle scattering amplitude. (auth)

34568 STATISTICAL ANALYSIS OF LOW-ENERGY FISSION. Erba, E.; Facchini, U.; Saetta-Menichella, E. (CISE, Milan. Univ. degli Studi, Milan). Nucl. Phys., 84: 595-608(1966).

The fission mechanisms in the reactions ^{235}U + thermal neutrons, ^{235}U + 14 Mev neutrons, ^{209}Bi + 42 Mev α-particles, ^{226}Ra + 9.8 Mev deuterons and ^{252}Cf spontaneous fission were analyzed by means of a statistical model. The total kinetic energy and mass distributions of the final fragments for the different reactions were estimated and were compared with the experimental data. The number of neutrons emitted by single fragments was also estimated in the case of ^{235}U + thermal neutrons and ^{252}Cf spontaneous fission. The most striking aspects of fission can be reproduced quite well. (auth)

34569 ALPHA-PARTICLE AND GAMMA-RAY SPECTRAL STUDIES OF ^{149}Gd AND ^{149}Eu. Williams, I. R.; Toth, K. S.; Handley, T. H. (Oak Ridge National Lab., Tenn.). Nucl. Phys., 84: 609-17(1966). (ORNL-P-2259).

The alpha-particle and photon spectra of ^{149}Gd and the photon spectrum of its daughter ^{149}Eu were studied with a Si(Au) surface-barrier detector, and with Ge(Li) and NaI(Tl) gamma spectrometers. The ^{149}Gd alpha particles were found to have an energy of 3.01 ± 0.01 Mev while the α/E.C. branching ratio was found to be $4.0 \pm 1.2 \times 10^{-6}$. The ^{149}Gd gamma transition energies, and the relative intensities were obtained. For ^{149}Eu, the photon energies and relative intensities were measured. The K-shell internal conversion coefficients were calculated by intercomparison of the photon intensity data with conversion electron intensity data of other workers. (auth)

34570 A REINVESTIGATION OF THE DECAY OF ^{149}Gd. Jaklevic, J. M.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Nucl. Phys., 84: 618-28 (1966). (COO-498-48).

The decay of ^{149}Gd to levels in ^{149}Eu was studied with a Ge–Li detector and a NaI detector in prompt and delayed coincidence. The source was produced by the $^{147}Sm(\alpha,2n)$ ^{149}Gd reaction and was chemically separated from the target material. Previously reported transitions were confirmed. Additional gamma rays were observed and were assigned to the decay. Internal conversion coefficients were determined by normalizing the gamma intensities as determined from the Ge–Li singles spectra to the electron intensities reported by Prask et al. A revised decay scheme is proposed. (auth)

34571 INVESTIGATION OF THE REACTION $^{32}S(d,p)^{33}S$ IN THE DEUTERON ENERGY RANGE 1.5 TO 2.5 Mev. Saad, H. R.; Saleh, Z. A.; Mansour, N. A.; Sayed, E. M.; Zaloubovsky, I. I. (Atomic Energy Establishment, Cairo). Nucl. Phys., 84: 629-40(1966).

The excitation functions and angular distributions of the first seven proton groups from the (d,p) reaction on ^{32}S have been measured. The excitation functions for all the groups show considerable fluctuations. The shape of the excitation curves measured at an angle of 150° differs from that observed at 30°. Moreover, most of the fluctuations for different proton groups are not correlated with each other. Angular distributions have been measured at ten deuteron energies. A considerable competition between the compound nucleus mechanism and direct processes is observed practically at all energies. No regularity is observed between the fluctuations in the excitation curves and angular distributions. Differential and total reaction cross sections are given. (auth)

34572 ELASTIC SCATTERING OF α PARTICLES BY ^{24}Mg IN THE ENERGY RANGE 8 TO 19 Mev. So, S. S.;

Mayer-Boericke, C.; Davis, R. H. (Florida State Univ., Tallahassee). Nucl. Phys., 84: 641-50(1966).

Excitation curves for $^{24}Mg(\alpha,\alpha)$ elastic scattering were measured at four angles in the energy range 8 to 19 Mev. The excitation curves show that the differential cross section fluctuates widely and rapidly about an average cross section which depends strongly on energy and traces broader structures typically about 1 Mev wide. The narrow fluctuation structure was analyzed and shown to resemble Ericson fluctuations with $\Gamma \lesssim 80$ kev. Eleven angular distributions were measured and were fitted by optical model analysis. Seven of these are in the region 12.30 to 14.00 Mev bombarding energy at maxima and minima of large fluctuations in the 90° cm excitation curve. Good fits were obtained with real well depths of about 110 Mev. The average of the seven angular distributions was separately analyzed, and the quality of the fit is comparable to or better than that of the individual angular distribution fits. (auth)

34573 A STUDY OF THE $^{40}Ca(t,\alpha)^{39}K$ REACTION AND THE SINGLE-HOLE STATES OF ^{39}K AND ^{39}Ca. Hinds, S.; Middleton, R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Nucl. Phys., 84: 651-60(1966).

Alpha-particle angular distributions from the $^{40}Ca(t,\alpha)^{39}K$ reaction at 9.57 Mev were measured using a multi-angle magnetic spectrograph. The positions of the single-hole states were determined by a pick-up analysis of the distributions. Evidence of appreciable configuration mixing in the ^{40}Ca ground state was also obtained. The energy levels of ^{40}Ca were studied using the $^{40}Ca(He\text{-}3,\alpha)^{39}Ca$ reaction. The single-hole states in ^{39}Ca were determined, and a mirror-nucleus comparison was made. (D.C.W.)

34574 LOW-ENERGY LEVEL SCHEME OF ^{46}Sc DEDUCED FROM THE $^{45}Sc(n,\gamma)^{46}Sc$ CAPTURE GAMMA RAYS. Van Assche, P.; Gruber, U.; Maier, B. P.; Koch, H. R.; Schult, O. W. B. (Technical Univ., Munich. Research Establishment, Risoe, Denmark). Nucl. Phys., 84: 661-72(1966).

The thermal-neutron capture gamma spectrum of the reaction $^{45}Sc(n,\gamma)^{46}Sc$ was measured with a bent-crystal gamma spectrometer. Some 27 gamma transitions out of a total of 53, representing nearly 95% of the sum of the measured intensities, were fitted in the level scheme. For most levels, spin and parity assignments are proposed and are discussed on the basis of the present experimental results. (auth)

34575 STRIPPING AND PICKUP REACTIONS ON THE CARBON ISOTOPES. Glover, R. N. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Jones, A. D. W. Nucl. Phys., 84: 673-82(1966).

The (d,p), (p,d), (t,d), and (d,t) reactions on the carbon isotopes were investigated with a semiconductor counter telescope and pulse multiplier system. Plane-wave analyses of these reactions were carried out as well as distorted-wave analyses of the $^{12}C(d,p)^{13}C$ and $^{12}C(t,d)^{13}C$ reactions. The variation of the plane-wave reduced widths with energy is obtained as well as values of the mass-three form factor. Spectroscopic factors are extracted from the distorted-wave analyses, and their variation with parameters investigated. Information is also obtained on the 6.58-, 7.01-, and 8.32-Mev levels in ^{14}C, and this is discussed in the light of other work on the mass-14 nuclei. (auth)

34576 GAMMA RAYS FROM POSITIVE PARITY STATES IN ^{15}N. Haeusser, O.; Gill, R. D.; Lopes, J. S.; Rose, H. J. (Oxford Univ.). Nucl. Phys., 84: 683-94 (1966).

The spins of the positive-parity levels at 5.27, 7.15, 7.30, and 7.56 Mev were confirmed to be 5/2, 5/2, 7/2, and 3/2, respectively. The multipole mixing ratios of the de-excitation gamma rays from these levels were determined. The result for the M2/E1 mixing ratio of the 7.30 → 0 Mev transition indicates a very unusual retardation of an E1 transition in a non-self-conjugate nucleus. An attempt was made to relate these results to the transition strengths observed in ^{16}O. (G.O.Y.)

34577 BINDING ENERGY OF NUCLEAR MATTER. Azziz, Nestor (Westinghouse Electric Corp., Atomic Power Div., Pittsburgh). Nucl. Phys., 85: 15-32(1966).

A new approximation for nuclear matter where the many-body G-matrix is calculated with zero self-energy for the particle states is explained. The method is used to calculate the binding energy and compressibility of nuclear matter. For the Hamada-Johnston potential, the binding energy is 8.3 Mev at a saturation point of $k_f = 1.35$ fm^{-1}. The corresponding values for the Brueckner-Gammel-Thaler potential are 14.3 Mev and 1.6 fm^{-1}. In general this approximation gives results very similar to that of Brueckner and Masterson. However, it is much simpler in structure. (auth)

34578 STRUCTURE OF FINITE NUCLEI AND THE FREE NUCLEON-NUCLEON INTERACTION. AN APPLICATION TO ^{18}O AND ^{18}F. Kuo, T. T. S.; Brown, G. E. (Princeton Univ., N. J.). Nucl. Phys., 85: 40-86(1966).

An investigation is made of the applicability of the free nucleon-nucleon potential determined by the scattering data in the shell-model description of finite nuclei. The potential is chosen to be that of Hamada and Johnston, and ^{18}O and ^{18}F as the first numerical calculations. The shell-model reaction matrix elements are evaluated using the separation method for the singlet-even and triplet-even states and the reference spectrum method for the singlet-odd and triplet-odd states. The second-order Born term for the triplet-even tensor force is found to be very important. It can be calculated conveniently and with good accuracy using the closure approximation with an energy denominator of ≈220 Mev. Assuming the single-particle wave functions to be those of a harmonic oscillator well, the single-particle energy levels of $0d_{\frac{5}{2}}$, $1s_{\frac{1}{2}}$ and $0d_{\frac{3}{2}}$ for ^{17}O are calculated by letting the valence nucleon interact with the ^{16}O core. The $0d_{\frac{5}{2}}-0d_{\frac{3}{2}}$ splitting is found to come mostly from the triplet-odd $1\cdot s$ force through the reaction matrix Hartree-Fock process. The spectra of ^{18}O and ^{18}F are satisfactorily reproduced by diagonalizing the model interaction $G\Omega_{3p1h}$ in the sd shell, except for the states that are presumed to be largely deformed; G is the reaction matrix and Ω_{3p1h} is the wave operator which takes care of the corrections arising from the one-particle-one-hole excitation of the ^{16}O core. It is found that the conventional shell-model effective interactions are well reproduced by the model interaction deduced from the free nucleon-nucleon potential. (auth)

34579 NUCLEAR COEXISTENCE IN THE OXYGEN REGION AND REALISTIC NUCLEON-NUCLEON FORCES. Brown, G. E. (Princeton Univ., N. J.); Green, A. M. Nucl. Phys., 85: 87-96(1966).

Deformed states in the oxygen region are constructed according to an isospin coupling scheme, which is discussed in detail. Matrix elements between these states and the usual shell-model states are calculated from the Hamada-Johnston nucleon-nucleon force, and are found to be in reasonable agreement with those needed empirically. Difficulties in interpretation of binding energies are discussed. (auth)

34580 SIZES OF 1p-SHELL NUCLEI. Wilkinson, D. H.; Mafethe, M. E. (Nuclear Physics Lab., Oxford). Nucl. Phys., 85: 97-113(1966).

Data on electron scattering, proton binding energies and Coulomb energies in nuclei of the 1p-shell are analyzed to give information on the nuclear size. The simplest model, a spherically symmetrical, velocity-independent potential of Saxon-Woods form is used; it is found that the parameters characterizing the nuclear size are essentially the same as deduced by the three methods and that there is no significant change in nuclear size through the shell. If we use a diffuseness parameter of a = 0.5 fm, the following quantities cover the entire shell: $\langle r^2\rangle m^{\frac{1}{2}} = 2.32 \pm 0.14$ fm; $R = 2.94 \pm 0.20$ fm; $V_0 = 61 \pm 6$ Mev; the rms radius refers to neutrons and protons taken together and all quantities are in the center-of-mass system. (auth)

34581 SINGLE-PARTICLE E2 RADIATIVE WIDTHS IN THE 1p SHELL. Wilkinson, D. H. (Nuclear Physics Lab., Oxford). Nucl. Phys., 85: 114-18(1966).

The best effective Saxon-Woods potentials for nuclei of the 1p shell derived from a study of electron scattering, proton binding energies and Coulomb energies are used to compute $\langle r^2\rangle_{pp}^{\frac{1}{2}}$ for the 1p shell protons. For all nuclei from

^{8}Be to the top of the shell the values are close to 2.50 fm. This implies a single-particle E2 transition strength for a spinless 1p proton of: $\Gamma_\gamma = 2.50 \times 10^{-6} E_\gamma^5$ ev, where E_γ is in Mev. (auth)

34582 SURFACE DELTA INTERACTION AND EXCITATIONS IN CLOSED SHELL NUCLEI. Letourneux, J.; Eisenberg, J. M. (Univ. of Virginia, Charlottesville). Nucl. Phys., 85: 119-28(1966). (ORO-2915-45).

A zero-range surface interaction, together with the particle-hole formalism, is used to discuss excitations in closed shell nuclei. This leads to considerable simplifications in comparison with conventional treatments since the diagonalization of large secular matrices is replaced by the solution of dispersion relations. The model is tested by applying it to ^{16}O, and a detailed study of ^{208}Pb in both the Tamm-Dancoff approximation and the random phase approximation is presented. The results compare quite favorably with those obtained using a more realistic interaction and with experiment. (auth)

34583 NEUTRON TOTAL CROSS SECTIONS IN THE ENERGY RANGE 80 TO 150 Mev. Measday, D. F. (Harvard Univ., Cambridge, Mass.); Palmieri, J. N. Nucl. Phys., 85: 129-41(1966).

The total neutron cross sections for helium, carbon, nitrogen, oxygen and aluminium were measured to an accuracy of 2% in the energy range of 80 to 150 Mev. Monokinetic neutron beams were used and the results are therefore free from the systematic errors associated with many earlier measurements. For carbon and aluminium the results are in excellent agreement with values obtained by time-of-flight techniques with good energy resolution. The oxygen cross sections are reasonably consistent with some earlier determinations at both ends of the energy range studied but are 10% smaller than some previous data in this energy range. The results presented for helium and nitrogen are in an energy region where few previous measurements were made. (auth)

34584 NEUTRON TOTAL CROSS SECTIONS FOR NEUTRONS, PROTONS, AND DEUTERONS IN THE ENERGY RANGE OF 90 TO 150 Mev. Measday, D. F. (Harvard Univ., Cambridge, Mass.); Palmieri, J. N. Nucl. Phys., 85: 142-52(1966).

The neutron total cross section for scattering by protons and deuterons was measured to an accuracy of 2% in the energy range of 90 to 150 Mev. Monokinetic neutron beams were used and the results are therefore free of the systematic errors associated with many earlier measurements. The n-p cross sections agree with an earlier measurement of Taylor, but below 100 Mev they are several per cent larger than the results of Bowen et al. The difference between the neutron cross sections for deuterium and hydrogen are consistent with the results of Riddle et al. below 120 Mev. The neutron-neutron cross sections were inferred, and they agree with the results of Riddle et al. (auth)

34585 SEARCH FOR THE 5.58 AND 6.40 Mev EXCITED STATES OF ^{10}B. Forsyth, P. D. (Univ. of Maryland, College Park); Knudson, A. R.; Young, F. C. Nucl. Phys., 85: 153-60(1966).

The energy levels of ^{10}B in the region of excitation from 5.0 to 6.6 Mev were studied through the ^{9}Be(^{3}He,d)^{10}B reaction at an incident energy of 9 Mev. Deuteron groups leaving ^{10}B in excited states at 5.11, 5.16, 5.92, 6.02, 6.13 and 6.57 Mev were observed. Deuteron groups corresponding to levels at 5.18, 5.58 and 6.40 Mev were not observed. The 6.13 and 6.57 Mev levels are believed to have positive parity and spins between one and three. (auth)

34586 ANGULAR DISTRIBUTIONS AND TOTAL CROSS SECTIONS OF THE ^{27}Al(^{3}He,p)^{29}Si REACTION FROM 5.4 TO 6.1 Mev. McGrath, Robert L. (Univ. of Iowa, Iowa City). Nucl. Phys., 85: 161-70(1966).

The angular distributions of protons from the ^{27}Al(^{3}He,p)^{29}Si reactions corresponding to the first seven levels of ^{29}Si are given for five bombarding energies between 5.4 and 6.1 Mev. The angle-integrated cross sections show a 2J + 1 dependence. The 2J + 1 dependence is found to be more reliable for the angular range between 82° and 142° than between 10° and 142°. The angle-integrated cross-section yield curves show pronounced structure. The apparent characteristic width is on the order of several hundreds of kev. (auth)

34587 STUDY OF THE REACTION ^{12}C(d,α)^{10}B FOR DEUTERON ENERGIES OF 9.2 TO 13.8 Mev. II. Baldeweg, F.: Bredel, V.; Guratzsch, H.; Klabes, R.; Kuehn, B.; Stiller, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., 85: 171-83(1966). (In German).

Previous measurements of the ^{12}C(d,α)^{10}B reaction leading to the ground state and three excited states of ^{10}B were extended in the range of small angles. The full curves were fitted by means of PWBAE theory with moderate success. For the group α_1, the relation of the L-components in the cross section was calculated using structure factors. The result is compared with the experimental values. (auth)

34588 STRUCTURE OF THE sd-SHELL NUCLEI. II. SPECTROSCOPIC FACTOR OF ONE-NUCLEON TRANSFER REACTION. Inoue, T. (Nihon Univ., Tokyo); Sebe, T.; Hagiwara, H.; Arima, A. Nucl. Phys., 85: 184-92 (1966).

Coefficients of fractional parentage of $(sd)^3$ and $(sd)^4$ are given. Wave functions of ^{20}Ne are presented and spectroscopic factors of the single-nucleon transfer are calculated. (auth)

34589 ANALYSIS OF CROSS-SECTION FLUCTUATIONS IN THE REACTION ^{26}Mg(p,α)^{23}Na. Allardyce, B. W. (Nuclear Physics Lab., Oxford); Dallimore, P. J.; Hall, I.; Tanner, N. W.; Richter, A.; Von Brentano, P.; Mayer-Kuckuk, T. Nucl. Phys., 85: 193-226(1966).

The reaction ^{26}Mg(p,α)^{23}Na was studied as a quantitative test of fluctuation theory. Excitation functions and angular distributions were measured using protons of energy 9 to 13.26 Mev in 20 kev steps. Good overall energy resolution was achieved and α-particles corresponding to the ground state and first three excited states in ^{23}Na were studied. All the excitation functions show marked fluctuations and were analyzed in terms of the auto-correlation function and the angular and group cross-correlation functions. The results do not agree with conventional statistical theory. Corrections were made to the simple theory to take account of the finite range of the data, and the presence of nonstatistical variations in the cross section. A "modulated fluctuation" analysis was made of the excitation functions and the results obtained agree well with the corrected theory. The implication is that the gross and probably intermediate structure of the compound state exerts a serious influence on the cross sections, and thereby invalidates the basis of the statistical description. It is possible to extract some information about this structure. (auth)

34590 DECAY OF ^{164}Ho. Sethi, B.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys., 85: 227-40(1966).

^{164}Ho activity is produced by bombarding natural holmium with 14 Mev neutrons. Two beta groups of 875 ± 20 and 965 ± 20 kev are measured using a lithium drifted silicon detector. Photons of 36, 46, 51, 72 and 90 kev are found and the decay of each is followed with a scintillation spectrometer. The β-γ, γ-γ and x-γ coincidence experiments are performed. A metastable state is found in ^{164}Ho. The half lives of the metastable and ground states of ^{164}Ho are found to be 39.0 ± 0.5 and 23.9 ± 0.5 min, respectively. The cross sections for the production of the two states by the (n,2n) reaction at 14 Mev neutron energy are estimated to be 1050 ± 100 and 730 ± 100 mb, respectively. The 51 and 36 kev gamma rays belong to the decay of ^{164m}Ho. (auth)

34591 SHELL STRUCTURE EFFECTS IN THE LEVEL DENSITY OF A FERMI SYSTEM. Rosenzweig, N. (Weizmann Inst. of Science, Rehovoth, Israel. Argonne National Lab., Ill.). Nuovo Cimento (10), 43B: 227-35(June 11, 1966).

An earlier calculation of the level density of a degenerate Fermi system of particles has been generalized by removing the g-fold degeneracy of an independent-particle level

in the form of a uniformly spaced cluster of single-particle levels. The result is still very simple and serves to illustrate that gaps, partially filled shells in the ground state, and other distinctive features of the single-particle spectrum in the schematic model, produce effects in the level density formula which are represented as additive corrections to the excitation energy. No attempt was made to fit actual nuclear data. (auth)

34592 PROPERTIES OF NUCLEAR MATTER AT HIGH DENSITIES. Cazzola, P. (Univ., Padua); Lucaroni, L.; Scarinci, C. Nuovo Cimento (10), 43B: 250-8(June 11, 1966).

An equation of state is given for a baryon gas at zero temperature, for densities larger than the nuclear density, in the assumption of a soft repulsive core. The possibility of formation of a lattice structure for the baryon matter in a particular range of densities is investigated. (auth)

34593 BINDING ENERGY OF A LAMBDA PARTICLE IN NUCLEAR MATTER. Ranft, G. (CERN, Geneva). Nuovo Cimento (10), 43B: 259-76(June 11, 1966).

The well depth D_Λ of a Λ particle in nuclear matter is calculated from the central and the tensor part of an effective Λ-nucleon potential which reproduces the low-energy Λ-nucleon data and has different hard-core radii in the singlet and the triplet state. The first-order contribution of the central potential to D_Λ is found to be in agreement with the experimental data if the rearrangement energy is taken into account and if the effective Λ mass M_Λ^* is taken smaller than the Λ mass M_Λ. The tensor contribution to D_Λ turns out to be very small. (auth)

34594 OPTICAL MODEL AT RELATIVISTIC ENERGIES. Elton, L. R. B. (Battersea Coll. of Tech., London). Nuovo Cimento (10), 43B: 277-81(June 11, 1966).

It is shown that relativistic corrections are easily incorporated in the usual nonrelativistic formalism of the optical model with spin-orbit coupling, and that there is no essential difference between the two cases which assume that the optical potential is either the fourth component of a Lorentz vector or a Lorentz scalar. (auth)

34595 COULOMB DISINTEGRATION OF LIGHT HYPERNUCLEI. Kolesnikov, N. N.; Vedrinskii, R. V. (Univ. of Moscow). Nuovo Cimento (10), 43B: 301-6(June 11, 1966).

The disintegration of the light hypernuclei in the Coulomb field of heavy nuclei is studied in detail. Besides the semi-classical consideration the quantum-mechanical low-energy and shock approximations were used. It is shown that in the case of sufficiently heavy nuclei the cross section of the Coulomb disintegration of $_\Lambda H^3$ exceeds largely that of nuclear stripping and can reach (10 – 50) barn. (auth)

34596 $^{12}C(\gamma,n)^{11}C$ CROSS SECTION ABOVE THE GIANT RESONANCE. Fossa, G. M. (Istituto Nazionale di Fisica Nucleare, Genoa); Ricco, G.; Manfredotti, C. Nuovo Cimento (10), 43B: 347-53(June 11, 1966).

The cross section for the reaction $^{12}C(\gamma,n)^{11}C$ above the giant resonance is measured up to 70 Mev of γ-ray energy. The Penfold and Leiss analysis gives a value of the integrated cross section of (88 ± 7) mb Mev in agreement with the classical dipole sum rule; the contribution between 35 and 70 Mev is about 30 mb Mev, i.e., 34% of the measured integrated (γ,n) cross section. A wide resonance at about 35 Mev mainly corresponding to $1s_{1/2}^{-1}\ 1p_{1/2}$ transition predicted by the particle-hole calculations has been observed. There is also some evidence of structure at about 53 Mev. (auth)

34597 DETERMINATION OF THE MAGNETIC MOMENT OF ^{239}Pu. Korostyleva, L. A. Opt. Spectros. (USSR) (Engl. Transl.), 20: 105-6(Feb. 1966).

Translated from Opt. Spektros., 20: 194-6(Feb. 1966).

A detailed analysis of the hyperfine structure (hfs) in the PuII spectrum was performed using new experimental data. As a result the magnetic splitting factors for the $^8F_{1/2}$, $^8F_{3/2}$, $^8F_{5/2}$, $^8F_{7/2}$, $^6F_{1/2}$, $^6F_{3/2}$, $^6F_{5/2}$ terms of the $5f^67s$ configuration were obtained. The average value of the magnetic splitting factor is $a_s = 0.301 \pm .014$ cm^{-1}. The value for the ^{239}Pu magnetic moment turned out to be +0.19 nm. (auth)

34598 PROTON CAPTURE BY DEUTERONS. Woelfli, W.; Boesch, R.; Lang, J.; Mueller, R.; Marmier, P. (Eidgenoessiche Technische Hochschule, Zurich). Phys. Lett., 22: 75-6(July 15, 1966).

The reaction $D(p,\gamma)^3He$ was investigated in the energy region from 2 to 12 Mev. The experimental results are compared with the predictions using the Gunn-Irving wave function for the ground state of the 3-nucleon system. (auth)

34599 $^7Li(p,\alpha)^4He$ REACTION WITH POLARIZED PROTONS. Boca, I.; Borsaru, M.; Cenja, M.; Hategan, C.; Iliescu, E. (Inst. for Atomic Physics, Bucharest). Phys. Lett., 22: 76-7(July 15, 1966).

The $^7Li(p,\alpha)^4He$ reaction was investigated using polarized protons in the energy range 5.5–6.7 Mev at θ(lab) 30° and 50°. The experimental data indicate that this reaction may be used as a polarization analyzer in this energy range. Preliminary theoretical investigations based on the level parameters of ^{8}Be obtained by Freeman and Mani do not explain the experimental results. (auth)

34600 ENERGY LEVELS OF ^{50}Ca. Vervier, J. (Centre d'Etude de l'Energie Nucleare, Mol, Belg.). Phys. Lett., 22: 82-4(July 15, 1966).

The energy levels of ^{50}Ca, its ground-state binding energy and relative cross sections in the $^{48}Ca(t,p)^{50}Ca$ reaction are successfully accounted for by shell model calculations. Further experiments are suggested. (auth)

34601 LEVEL SHIFTS IN K-MESONIC ATOMS. Uretsky, Jack L. (Argonne National Lab., Ill.). Phys. Rev., 147: 906-9(July 29, 1966).

A recent experiment on K^- capture at rest on ^{4}He failed to observe any perturbing effect upon the Coulomb levels of the K-mesic atom from the K^- nuclear interaction. This result was considered to be surprising because the S-wave $\bar{K}$-nucleon forces are known to be strong, at least in the isospin-zero channel. An attempt is made to explain the apparent weakness of the K^--^{3}He forces by a Born-Oppenheimer estimate of the effective potential. The result contains the range of the $\bar{K}$-N force as an undetermined parameter; an upper bound is obtained from the result of the K^--^{4}He experiment. Predictions (upper bounds) are then made for other very light nuclei. (auth)

34602 SUM RULES IN NUCLEAR BETA DECAY. Kim, C. W.; Primakoff, H. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 147: 1034-7(July 29, 1966).

The previously developed elementary-particle treatment of nuclear beta decay, $N_i \rightarrow N_f + e^\mp + \nu_e$, is combined with the Adler-Weisberger procedure, to obtain sum rules relating axial-vector coupling constants for nuclear beta decays, $G_A(N_i \rightarrow N_f)$, to integrals over pion energy of pion–final-nucleus total cross sections, $I(\pi^\pm,N_f)$. It is shown that the ratio $[I(\pi^\pm,N_f)/I(\pi^\pm,p)] = -[I(\pi^\pm,N_f)/I(\pi^\pm,n)]$ is just equal to the difference between the number of protons and the number of neutrons in N_f, $[Z-(A-Z)]$, multiplied by a factor which becomes unity in the approximation of neglect of meson-exchange corrections to $G_A(N_i \rightarrow N_f)$. (auth)

34603 NUCLEAR ALIGNMENT IN HEAVY-ION REACTIONS. Diamond, R. M.; Matthias, E.; Newton, J. O.; Stephens, F. S. (Univ. of California, Berkeley). Phys. Rev. Lett., 16: 1205-7(June 27, 1966).

Results are presented which show that a large and reasonably uniform degree of alignment is present throughout the neutron and gamma cascades following heavy-ion nuclear reactions. The use of heavy-ion reactions as a tool in nuclear spectroscopy is emphasized. (G.O.Y.)

34604 PSEUDOQUADRUPOLE SHIFT OF GAMMA RESONANCE SPECTRA. Clauser, M. J.; Kankeleit, E.; Moessbauer, R. L. (California Inst. of Tech., Pasadena). Phys. Rev. Lett., 17: 5-8(July 4, 1966). (CALT-63-39).

Pseudoquadrupole shifts of the 8.4-kev gamma transition of ^{169}Tm in $TmCl_3 \cdot 6H_2O$ and $Tm_2(SO_4)_3 \cdot 8H_2O$ were observed. (B.G.D.)

34605 INELASTIC ELECTRON SCATTERING FROM THE FIRST EXCITED STATE OF ^{58}Ni, ^{60}Ni, AND ^{62}Ni. Duguay, M. A.; Bockelman, C. K.; Curtis, T. H.; Eisenstein, R. A. (Yale Univ., New Haven). Phys. Rev. Lett., 17: 28-30(July 4, 1966).

A set of inelastic form-factor measurements are presented on the first excited state of ^{58}Ni, ^{60}Ni, and ^{62}Ni, which, together with the accurate Coulomb-excitation B(E2) measurements by McGowan and Stelson, provide for the first time an accurate experimental check on the distorted-wave calculation of Griffy et al. (B.G.D.)

34606 PHOTOTRITONS FROM ^{6}Li. Sherman, N. K.; Stewart, J. R.; Morrison, R. C. (Yale Univ., New Haven). Phys. Rev. Lett., 17: 31-3(July 4, 1966).

A measurement is reported of the cross section for the reaction ^{6}Li(γ,t) for photon energies between 19 and 24 Mev. (B.G.D.)

34607 PHYSICAL SIGNIFICANCE OF OPTICAL-MODEL PARAMETERS. Greenless, G. W.; Pyle, G. J.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Phys. Rev. Lett., 17: 33-6(July 4, 1966).

An analysis of the optical model is presented in which the difference between the radii for the real central potential and the spin-orbit potential can be interpreted in terms of the interaction of the incident proton with the nuclear matter distribution via the two-body nucleon-nucleon force. To accomplish this it was necessary to recognize the particular components of the two-body force giving rise to the two potentials and to adopt an appropriate folding procedure. (B.G.D.)

34608 SPIN-SPIN INTERACTION IN THE TOTAL CROSS SECTION FOR POLARIZED 7.85-Mev NEUTRONS ON POLARIZED ^{165}Ho. Fisher, T. R. (Stanford Univ., Calif.); Shelley, E. G.; Safrata, R. S.; McCarthy, J.; Barrett, R. C. Phys. Rev. Lett., 17: 36-8(July 4, 1966).

A search for the spin-spin interaction in the total cross section for 7.85-Mev neutrons on ^{165}Ho is reported. (B.G.D.)

34609 NUCLEAR LEVEL STRUCTURE OF ^{6}Be. Rogers, P. C.; Wegner, H. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 17: 148-9(July 18, 1966). (BNL-10243).

Measurements on the levels of ^{6}Be carried out with the reaction ^{6}Li(^{3}He,t)^{6}Be are reported. A single broad state was observed in ^{6}Be at an excitation energy of 1.63 ± 0.10 Mev with width 1.20 ± 0.1 Mev and no other statistically significant structure up to an excitation energy of 10 Mev. In addition to energy measurements, angular distributions of tritons leading to the ground and first excited states of ^{6}Be were measured in 2.5-deg steps from 10.0 to 70 deg. (B.G.D.)

34610 THE HALF-LIFE OF ^{89m}Nb. Hanser, A.; Flegenheimer, J. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 5: 120(May 1966).

The 590-kev gamma transition of ^{89m}Zr to the ground state is partially converted and this property makes possible the direct measurement of the ^{89m}Nb isomer half life by means of an electron solid state detector. The half life was found to be 66 ± 4 min. (M.C.G.)

34611 GAMMA EMISSION IN ^{101}Mo DECAY. Cretu, T.; Hohmuth, K.; Schintlmeister, J. (Central Inst. of Nuclear Research, Rossendorf, Ger.). Rev. Roum. Phys., 11: 143-51(1966). (In German).

The decay of ^{101}Mo to ^{101}Tc was studied by means of a gamma scintillation spectrometer and a pair spectrometer. A two-dimensional coincidence apparatus with a 2048-channel ferrite-core storage was used for recording the γ-γ coincidences. The measurement of the pair spectra yielded three new gamma transitions in ^{101}Tc with energies 1800, 1890, and 2160 kev. By introducing a new level at 2270 kev the 80-1680 kev and 190-2080 kev cascades could be included in the ^{101}Mo decay scheme. The intensities of the gamma transitions were determined. The decay scheme of ^{101}Mo is presented. (tr-auth)

34612 GAMMA-GAMMA DIRECTIONAL CORRELATION IN ^{143}Pr. Badica, T. (Inst. of Atomic Physics, Bucharest); Deciu, N.; Gelberg, A.; Kemeny, P.; Mihai, Roza. Rev. Roum. Phys., 11: 179-90(1966).

The γ-γ directional correlation in ^{143}Pr was studied with a three-detector automatic experimental arrangement. A thin NaI(Tl) crystal recorded soft gamma rays. Spin assignments were made and the results were discussed in terms of some theoretical models. (auth)

34613 METHODS OF CONTROLLED ENERGY VARIATION OF NEUTRON-CAPTURE GAMMA RADIATION. Randall, John D. (Texas Agricultural and Mechanical Univ., College Station). Trans. Amer. Nucl. Soc., 9: 99-100(June 1966).

34614 REACTOR PRODUCTION OF CARRIER-FREE ^{141}Ce FROM LANTHANUM AND PRASEODYMIUM. O'Brien, H. A. Jr.; Eldridge, J. S. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 101-2(June 1966).

34615 ABSOLUTE CROSS SECTIONS AND EXCITATION FUNCTIONS FOR SOME ALPHA-PARTICLE INDUCED REACTIONS OF ^{165}Ho, ^{164}Er, ^{166}Er, ^{167}Er. Martin, G. C. Jr. (General Electric Co., Pleasanton, Calif.); Pilger, R. C. Jr. Trans. Amer. Nucl. Soc., 9: 109-11 (June 1966).

34616 CADMIUM FILTER EFFECTS ON GOLD-FOIL ACTIVATIONS. Pearlstein, S.; Weinstock, E. V. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 190(June 1966).

34617 LOW FLUX MEASUREMENT OF ^{235}U EPICADMIUM CAPTURE-TO-FISSION RATIO. Redman, W. C. (Argonne National Lab., Ill.); Bretscher, M. M. Trans. Amer. Nucl. Soc., 9: 245(June 1966).

34618 MEASUREMENTS OF THE EPITHERMAL-NEUTRON CAPTURE-TO-FISSION CROSS-SECTION RATIOS IN ^{233}U AND ^{235}U. Conway, D. E.; Gunst, S. B. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 245-6(June 1966).

34619 MEASUREMENTS OF THE ^{233}Pa RESONANCE INTEGRAL. Connor, J. C.; Bayard, R. T.; Macdonald, D.; Gunst, S. B. (Bettis Atomic Power Lab., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 246-7(June 1966).

34620 THE INFINITELY DILUTE RESONANCE INTEGRAL OF ^{186}W. Beller, L. S.; Latham, D. W. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 247-8(June 1966).

34621 RESONANCE INTEGRALS OF RHENIUM AND TUNGSTEN. Sher, R. (Stanford Univ., Calif.); LeSage, L.; Connolly, T. J.; Brown, H. L. Trans. Amer. Nucl. Soc., 9: 248-9(June 1966).

34622 CROSS SECTIONS FOR TRANSURANIUM ELEMENTS. Pearlstein, S. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 249-50(June 1966).

34623 FORMULA FOR THE (n,2n) CROSS SECTION BASED ON THE COMPOSITE DESCRIPTION OF NUCLEAR-LEVEL DENSITIES. Carter, H. G.; Williams, J. R. (General Dynamics Corp., Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 9: 250-1(June 1966).

34624 USE OF PROMPT-GAMMA-ENERGY YIELD TO ESTIMATE THE 14-Mev ^{51}V(n,2n)^{50}V CROSS SECTION. Williams, J. R.; Western, G. T.; Carter, H. G. (General Dynamics Corp., Fort Worth, Tex.). Trans. Amer. Nucl. Soc., 9: 251-2(June 1966).

34625 EXPERIMENTAL STUDY OF THE TIME DEPENDENCE OF THE BETA-ENERGY SPECTRUM FROM ^{235}U FISSION FRAGMENTS. Kutcher, J. W. (Battelle-Northwest, Richland, Wash.); Wyman, M. E. Trans. Amer. Nucl. Soc., 9: 252(June 1966).

34626 MONTE CARLO CALCULATIONS OF RESONANCE INTEGRAL OF ^{232}Th AND COMPARISONS WITH

EXPERIMENTAL RESULTS. Sehgal, Bal Raj (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 256-7(June 1966). (BNL-9962).

34627 DOPPLER-EFFECT OF $^{235}U/^{238}U$ MIXTURES. Till, C. E.; Lewis, R. A.; Groh, E. F. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 259-60 (June 1966).

34628 MESONIC DECAYS OF HYPERNUCLEI FROM K^- MESON AND Σ^- HYPERON CAPTURES AT REST IN NUCLEAR EMULSION. PART I. UNIQUELY IDENTIFIED HYPERNUCLEI. EUROPEAN K^- COLLABORATION. Univ. Brux. Inst. Phys., Bull. No. 26, 1-82(Apr. 1966).

A tabulation of the original data concerning the π^- and π^+ mesonic decays of hypernuclei produced in the absorption of K^- mesons and Σ^- hyperons at rest in nuclear emulsion is given. Only the uniquely identified hypernuclei are covered. The experimental arrangement is discussed. (M.H.R.)

34629 MESONIC DECAYS OF HYPERNUCLEI FROM K^- MESON AND Σ^- HYPERON CAPTURE AT REST IN NUCLEAR EMULSION. PART II. NON-UNIQUELY IDENTIFIED HYPERNUCLEI. EUROPEAN K^- COLLABORATION. Univ. Brux. Inst. Phys., Bull. No. 27, 1-94 (Apr. 1966).

A tabulation of the original data obtained by the European K^- collaboration concerning the π^- and π^+ mesonic decays of hypernuclei produced in the absorption of K^- mesons and Σ^- hyperons at rest in nuclear emulsion is given. It contains the events which were not uniquely identified. (M.H.R.)

34630 STUDIES IN THE FIELD OF GAMMA RESONANCE SPECTROSCOPY. Gol'danskii, V. I. Vestn. Akad. Nauk SSSR, No. 4, 44-76(Apr. 1966). (In Russian).

Nuclear recoilless gamma resonance discovered by Mössbauer has found many applications in science because of the precision of the effect. The displacement of an atom in a molecule or crystal lattice, the electron density around a nucleus, quadrupole splitting, and magnetic splitting can be detected by gamma resonance spectroscopy. The electric and magnetic moments of excited nuclei can be obtained from data on quadrupole and magnetic splitting. Recoilless gamma resonance (RGR) is used to obtain the properties and structures of compounds. Equipment based on the Mössbauer effect was developed to search for tin deposits. Relative motion such as acceleration or rotation can be detected by recoilless gamma resonance. (TTT)

34631 PROTON ANGULAR DISTRIBUTION IN THE $^{12}C(d,p)^{13}C$ AND $^{40}Ca(d,p)^{41}Ca$ GROUND-STATE REACTIONS. Mao, Chen-lin; Liang, Wen-hsueh; Chiang, Cheng-lieh; Yu, Pan-hsia; Cheng, Yeh-hao; Ho, Tse-jan; Chou, Shan-chu; Chao, Chung-yao. Wu Li Hsueh Pao, 22: 440-8(Apr. 1966). (In Chinese).

The angular distributions and the differential cross sections of the protons from the ground-state reactions $^{12}C(d,p)^{13}C$ and $^{40}Ca(d,p)^{41}Ca$ were measured at a deuteron energy of 13.3 Mev. The measurements were made at 2.5 or 5.0° intervals and covered the angular range from 3 to 167° and from 10 to 164° for the ^{12}C and ^{40}Ca reactions, respectively. The data were analyzed using the Butler theory, but the results of the analysis indicate that the data should be re-examined using the distorted-wave theory instead. (G.O.Y.)

34632 LEVEL-CROSSING EXPERIMENT TO STUDY THE HYPERFINE STRUCTURE OF ^{197}Au IN THE $5d^{10}$ 6p $^2P_{\frac{1}{2}}$-TERM. Bucka, H.; Ney, J. (Technische Univ., Berlin). Z. Phys., 194: 208-10(1966). (In German).

The scattering of Au-resonance line $\lambda = 2427$ Å on an atomic beam was observed in external magnetic field by level crossing technique. Using the assumed interpretation $B/A \gg 1$ for the hyperfine structure-interaction of ^{197}Au in the $^2P_{\frac{1}{2}}$-term a value $B \approx 11$ mK for the nuclear quadrupole-interaction constant is deduced. (auth)

34633 L/K CAPTURE RATIO OF ^{51}Cr. Heuer, W. (Univ., Muenster, Ger.). Z. Phys., 194: 224-33(1966). (In German).

The L/K-capture ratio of ^{51}Cr was investigated. The values obtained for the transitions to the first excited state of ^{51}V and for both transitions to the first excited state and the ground state of ^{51}V are $(N_L/N_K)_A = 0.1044 \pm 2\%$ and $(N_L/N_K)_G = 0.1033 \pm 3\%$ respectively. They are in fairly good agreement with theoretical results that take exchange corrections into account. But there still remains a dependence of the results on the method used to obtain the capture numbers from the measured spectrum. (auth)

34634 RELATIVE MEASUREMENTS OF THE LONGITUDINAL ELECTRON POLARIZATION IN THE β DECAY OF ^{114}In AND ^{32}P. Loehken, Rudolf; Rebel, Heinigerd (Univ., Heidelberg). Z. Phys., 194: 234-8(1966).

The ratio of the longitudinal polarization values of ^{114}In and ^{32}P was measured at two energies by the method of double scattering. The result obtained is $P(^{114}In)/P(^{32}P) = 0.974 \pm 0.029$ at 310 kev electron energy and $P(^{114}In)/P(^{32}P) = 1.007 \pm 0.026$ at 540 kev. (auth)

34635 DECAY OF CESIUM ISOTOPES ^{129}Cs AND ^{130}Cs. Gfoeller, D.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys., 194: 239-47(1966). (In German).

$^{129}Cs(T_{\frac{1}{2}} = 32$ h) and $^{130}Cs(T_{\frac{1}{2}} = 30$ min) were produced by $^{127}I(\alpha,2n)^{129}Cs$ and $^{127}I(\alpha,n)^{130}Cs$ reactions, respectively. The γ-ray spectra from the decays of ^{129}Cs and ^{130}Cs were investigated using Li-drifted Ge-counters and scintillation spectrometers. In the decay of ^{129}Cs 15 γ rays were observed having the following energies and relative intensities: 95 kev (1.6), 177 kev (1.1), 267 kev (1.7), 278 kev (4.8), 317 kev (7.6), 371 kev (100), 410 kev (69), 511 kev ($\leq$0.1), 548 kev (10.5), 587 kev (1.7), 623 kev (0.12), 660 kev (0.07), 864 kev (0.09), 907 kev (0.67), and 948 kev (0.2). The electron capture branching ratios to the ground state and excited states of ^{129}Xe were determined; log ft values for the various decay branches were derived from these ratios. In the decay of ^{130}Cs two γ transitions with the following energies and intensities relative to the β^+ emission have been found: 535 kev (11) and 585 kev (1.3). A new level at 1122 kev in ^{130}Xe is proposed. (auth)

34636 RESONANCE SCATTERING FROM THE 202.8-kev LEVEL IN ^{127}I. Frevert, L.; Schoett, W.; Langhoff, H.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys., 194: 248-52(1966). (In German).

Using a gaseous ^{127}Xe source as exciting radiation resonance fluorescence from the 202.8 kev level in ^{127}I was observed. The detection of the weak resonance effect in the presence of a strong 375 kev radiation was possible because of the high energy resolution of a Li-drifted germanium detector. Assuming a transition energy of $Q_{EC_0} = 543$ kev for the $^{127}Xe - ^{127}I$ decay the mean lifetime of the 202.8 kev level was determined to be $\tau = (0.56 \pm 0.09)$ nsec. (auth)

34637 CONVERSION ELECTRON SPECTRUM OF ^{150}Sm AFTER NEUTRON CAPTURE. Elze, Thomas W. (Technische Hochschule, Munich). Z. Phys., 194: 280-310(1966). (In German).

The spectrum of internal conversion electrons emitted by ^{150}Sm after neutron capture was measured by means of the beta spectrometer at the research reactor at Garching near Munich. Between 3 kev and 8 Mev, 392 conversion lines corresponding to 337 transitions were found. The multipolarity of most transitions could be determined uniquely, the energy of the conversion electrons was measured within an accuracy of $\geq 2.5 \times 10^{-4}$. An extension of the level scheme of ^{150}Sm is proposed. (auth)

34638 MEASUREMENT AND ANALYSIS OF PROTON ELASTIC SCATTERING FROM MEDIUM WEIGHT NUCLEI AT 14.5 Mev. Heagerty, Daniel Edward. Boulder, Colo., Univ. of Colorado, 1965. 109p.

Thesis.

The differential elastic scattering cross sections for 14.5-Mev protons from various isotopes of iron, nickel, copper, zinc, zirconium, and tin were measured and analyzed. The measurements were performed using the University of Colorado variable-energy sector-focussed cyclotron, a 36-inch scattering chamber, and silicon sur-

face-barrier, solid-state detectors. The differential cross sections were measured every 5° in scattering angle from 20 to 160°. An optical model analysis was performed searching on optical potential parameters. This analysis was done with the aid of computer codes that have automatic search subroutines. For the most part, both the differential elastic cross sections and the polarizations were fitted simultaneously. The analysis shows that the results can be accounted for using basically the same geometrical parameters as given by Perey. This geometry was modified by increasing the absorption diffuseness parameter and decoupling the spin-orbit radius. The well depths of the real and imaginary potentials vary smoothly from nucleus to nucleus in a manner given by other analyses. The well depth of the spin-orbit potential also shows a smooth variation, but attempts to predict its variation were unsuccessful. Both a volume term and a surface-peaked term were tried for the spin-orbit potential, and the analysis could not predict the preferred functional form. The analysis preferred a surface-peaked absorption term to a volume absorption term. (Dissertation Abstr.)

34639 STUDY OF THE (p,α) REACTION ON MEDIUM-WEIGHT NUCLEI AT 28 Mev. Bardin, Bryce Matterson. Boulder, Colo., Univ. of Colorado, 1965. 89p.

Thesis.

A survey of the (p,α) reaction on medium-weight nuclei was undertaken at 28 Mev. A new technique of alpha-particle identification was developed, which permitted an extended range of energy coverage. It was shown that direct reactions to levels of relatively high excitation in the residual nucleus are practically free from interference due to alpha-particle evaporation if the incident energy is sufficiently high. The alpha-particle evaporation process at this energy was found to be essentially identical with that at lower energy. The $^{59}Co(p,\alpha)^{56}Fe$ evaporation spectrum exhibited a constant-temperature form of level density, with the temperature of the residual ^{56}Fe nucleus equal to 1.50 ± 0.05 Mev. In the study of discrete levels, targets of ^{50}Ti, ^{54}Fe, ^{56}Fe, and ^{58}Fe were bombarded. Work on the excited states of ^{51}Mn demonstrates one of the virtues of the (p,α) reaction: its ability to reach states that are difficult, if not impossible, to reach by other methods. A possible isobaric analogue to the ground state of ^{47}Ca was identified in ^{47}Sc at 8.45 Mev and, similarly, a possible analogue to the ground state of ^{51}Cr was seen in ^{51}Mn at 5.14 Mev. Experimental evidence was found for the excitation of $d_{\frac{3}{2}}$ hole states in ^{45}Sc and ^{47}Sc. The experimental results are compared with pure $1f_{\frac{7}{2}}$ configuration shell-model predictions. (Dissertation Abstr.)

34640 DECAY OF ^{40}Sc AND ^{32}Cl. Anderson, William Charles. Boulder, Colo., Univ. of Colorado, 1965. 168p.

Thesis.

The decay of ^{40}Sc and ^{32}Cl, both of which are members of the A = 4n series, was studied. These short-lived nuclei were produced by a (p,n) reaction on ^{40}Ca and ^{32}S, respectively, using a bombarding energy of 25 Mev to surmount the high thresholds. A fast target transfer system was used in conjunction with a method of time gating a multichannel pulse height analyzer to selectively investigate the fractional second components. Data regarding the gamma de-excitation of the nuclear levels were obtained with NaI counters whereas the precise measurements of the gamma decay energy were made with a lithium-drifted germanium detector. The positron end-points were accurately measured with a plastic scintillation detector. On the basis of the analysis of singles and coincidence gamma spectra, six previously unreported gamma transitions in Ca are reported. Two additional low-intensity transitions in ^{32}S were discovered. Conclusive gamma-gamma coincidence measurements in parallel with the high resolution data observed with the germanium detector placed the analogue states at 7.646 ± 0.009 Mev in ^{40}Ca and 7.014 ± 0.010 in ^{32}S. The observed intensities of the gamma transitions were used in conjunction with the accurately measured positron end-points of ^{40}Sc (9.10 ± 0.090 Mev) and ^{32}Cl(9.45 ± 0.090 Mev) to obtain more precise evaluations of the ft values for the super allowed positron transitions. From arguments based on the nature of the super allowed transition and from observed allowed positron transitions to known states, the spin and parity of the ^{40}Sc ground state is tentatively identified at 4^- and the ^{32}Cl ground state as 2^+. (Dissertation Abstr.)

34641 ELASTIC SCATTERING OF PROTONS BY ^4He FROM 20 TO 28 Mev. Allison, Paul Walker. Boulder, Colo., Univ. of Colorado, 1965. 111p.

Thesis.

The elastic scattering cross section of protons from ^4He was measured at about 50 laboratory angles from 6 to 172° for four different laboratory energies from 20 to 28 Mev with an overall accuracy of about 2%. The differential cross section near 23 Mev was found to have an anomalous behavior. Subsequently the differential cross section was measured as a function of energy at two different angles from 20 to 28 Mev in energy steps as small as 80 kev. A resonance was found and interpreted as an energy level at 16.55 ± 0.10 Mev in the compound nucleus, ^5Li. A theoretical fit to the data was attempted, and the parameters of the fit are discussed in terms of the spin, parity, excitation energy, and width of the state. (Dissertation Abstr.)

34642 STUDIES OF ODD-A NUCLEI IN THE 2s-1d SHELL. Allen IV, Joseph Percival. New Haven, Yale Univ., 1965. 208p.

Thesis.

Experimental measurements of a number of level parameters in 2s-1d shell nuclei were carried out, and attempts were made to interpret these new data in terms of the corresponding predictions of currently existing nuclear models, including the asymmetric rotor model, the individual-particle spherical shell model, and the Nilsson unified model. Studies of gamma radiation following resonant proton capture by ^{18}O established the angular momentum of the 3.91-Mev state of ^{19}F as $\frac{3}{2}$ and, when coupled with previously reported data, established the angular momentum of the 2.79-Mev ^{19}F state as $\frac{5}{2}$. Precise gamma de-excitation branching ratios of the 3.91- and 8.76-Mev levels of ^{19}F were determined. Gamma radiation studies of the $^{18}O(d,p)^{19}O$ reaction established the spin of the 0.096-Mev state of ^{19}O as unambiguously $\frac{3}{2}$ and the spin of the ground state as most probably $\frac{5}{2}$. The de-excitation branching ratio of the ^{19}O 1.47-Mev state was accurately measured. No evidence for gamma radiation de-exciting a recently reported 0.348-Mev state of ^{19}O was found. Finally, measurements were made of de-excitation branching ratios and radiation angular correlations of transitions originating from particular states in the systems ^{21}Na, ^{21}Ne, ^{23}Na, and ^{23}Ne. Qualitative investigations of proton angular distributions from the reaction $^{22}Ne(d,p)^{23}Ne$ were carried out and suggest J^π assignments of $\frac{5}{2}^+$, $\frac{1}{2}^+$, $\frac{7}{2}^+$, and $\frac{1}{2}^+$ to the 0, 1.02, 1.83, and 2.32 Mev states of ^{23}Ne, respectively. Further experimental investigations of interest as suggested by these and other related studies are discussed. (Dissertation Abstr.)

34643 STUDY OF THE DEUTERON PLUS ALPHA PARTICLE BREAKUP REACTIONS. Nagatani, Kunio. New Haven, Yale Univ., 1965. 99p.

Thesis.

Alpha-particle-induced deuteron breakup reactions were studied in single-counter measurements at incident alpha-particle energies of 41.6 and 29.3 Mev. Simultaneous differential and total cross section measurements were carried out on protons, deuterons, and alpha particles. Unambiguous evidence for final state resonance effects in the alpha-nucleon interactions was obtained, particularly from the proton energy spectra; the $P_{\frac{3}{2}}$ alpha-nucleon resonances corresponding to the ^5He and ^5Li ground states play important roles. Phase space factor and zero range Born approximation calculations failed to reproduce the proton energy spectra. A more exact treatment that involves the resonance effect in the alpha-nucleon interaction explicitly does provide good agreement with the experimental results. It is demonstrated that study of these breakup reactions may provide a relatively sensitive probe for details of the deuteron wave functions used. (Dissertation Abstr.)

34644 FAST NEUTRON CROSS-SECTIONS OF ALUMINUM, SODIUM, AND BERYLLIUM. Chien, Ji-Peng. Ann Arbor, Mich., Univ. of Michigan, 1965. 115p.

Thesis.

The differential elastic scattering cross sections of aluminum, sodium, and beryllium and the differential inelastic scattering cross sections of aluminum and sodium were measured using time-of-flight techniques for neutron energies from 0.3 to 1.5 Mev. The inelastic excitation of states in aluminum of 842 and 1013 kev and in sodium at 438 kev was observed. The experimental differential elastic scattering cross sections were compared with the results of optical model calculations. Good agreement between theory and experiment was obtained only with a volume absorption term included in the optical potential. The measured differential inelastic scattering cross sections were interpreted in terms of Hauser-Feshbach theory including corrections for width fluctuation effects. The resulting calculated inelastic scattering cross sections compare reasonably well with the experimental values. The aluminum total cross sections were determined from ~0.3–1.5 Mev using monoenergetic neutron source (resolution ~2 kev) and also time-of-flight techniques (resolution ≳.8 kev). The observed complex resonance structure was fitted by the method of least squares with resonance formula to obtain resonance parameters. Twelve energy levels and their quantum state assignments in the compound nucleus ^{28}Al were suggested. The sodium total cross sections were determined from ~0.2–0.7 Mev. Intermediate resonances were observed in this energy range. (Dissertation Abstr.)

34645 GROUP THEORETIC MODEL INTERACTIONS AS AN APPROACH TO 2s-1d SHELL NUCLEI. THE LEVEL STRUCTURE OF ^{20}F. de Llano, Manuel Jr. Washington, D. C., Catholic Univ. of America, 1965. 248p.

Thesis.

Based on the studies of S. Lie and E. Cartan in the theory of continuous groups of transformations, M. Moshinsky has reformulated the nuclear shell many-body problem in second-quantization language. The methods due to J. P. Elliott for simplifying the basis set of state functions by classification according to the group SU(3) are recast into the above reformulation. The purpose is to make low-energy nuclear calculations feasible for nuclei with 4 and more particles in the 2s-1d shell and thus render the possibility of probing for SU(3) symmetries in these nuclei. A hamiltonian model consisting of pairing and quadrupole-quadrupole terms is known to approximate respectively the short- and long-ranged correlations between nucleons given by an arbitrary, reasonably shaped two-nucleon central interaction potential. The former model is generalized to include exchange effects at the long range as well as spin-orbit couplings, and is studied in detail from the viewpoint of its various group symmetries. It is then employed to calculate the low-lying levels of fluorine-20, which show reasonable accord with the empirical level scheme. (Dissertation Abstr.)

34646 GAUGE-INVARIANT TREATMENT OF INDUCED EFFECTS IN BETA-DECAY AND AN ANALYSIS OF THE ^{6}Li RECOIL SPECTRUM. Kim, Sung Kyu. Durham, N. C., Duke Univ., 1965. 69p.

Thesis.

The recoil momentum spectrum is calculated from the beta spectrum and electron-neutrino angular correlation for a Gamow-Teller allowed transition. The calculated spectrum includes the weak magnetism and induced pseudoscalar coupling terms, the finite de Broglie wavelength term, and the second-forbidden nuclear matrix element ratio terms. In particular, the spectral effect of induced tensor coupling is considered, because its existence would imply that G invariance is violated in the weak interaction. The gauge-invariance of the effective interaction operator appropriate for small momentum transfer is duly respected. When the Coulomb effect terms are neglected, the recoil momentum spectrum is independent of the weak magnetism coupling effect. The induced tensor coupling strength, $\underline{b}$, is estimated from a least squares analysis of the ^{6}Li recoil data. The ratio of correction factors of the ^{12}C momentum spectra from ^{12}B and ^{12}N beta decay is computed, and the deviation due to induced tensor coupling is determined with the above estimate of $\underline{b}$. (Dissertation Abstr.)

34647 ELECTRON SCATTERING FROM AN ALIGNED DEFORMED NUCLEUS. Greenstein, Howard Burt. Stanford, Calif., Stanford Univ., 1965. 169p.

Thesis.

The problem of scattering high-energy electrons from a deformed nucleus aligned in a magnetic field is considered from the point of view of the Schiff approximation for high-energy potential scattering. Integrals for the scattering amplitude are evaluated in the asymptotic limit of large $\beta(\beta \equiv QR)$ assuming a model for the charge density distribution equivalent to a uniformly charged ellipsoid of revolution. It is found that terms bilinear in the quadrupole strength must be retained. The formalism is extended to take account of nuclear spin state transitions. Low-lying rotational levels are summed over using the Bohr-Mottelson model in the strong coupling limit. Application is made to the case of the holmium nucleus, the results being presented in the form of graphs of the cross section versus the scattering angle. (Dissertation Abstr.)

34648 SOME APPLICATIONS OF THE BRUECKNER-BETHE-GOLDSTONE THEORY IN NUCLEAR PROBLEMS. Wong, Chun Wa. Cambridge, Mass., Harvard Univ., 1965. 213p.

Thesis.

In the case of nuclear matter, attempts are made to understand the discrepancy between the observed and the calculated properties of nuclear matter and to investigate the accuracy of available calculational techniques. A correct treatment of off-the-energy-shell effects by the reference-spectrum method of Bethe, Brandow, and Petschek emphasizes the importance of short-range repulsion in the nucleon-nucleon potential and increases the above discrepancy, by approximately 6 Mev for the Yale potential. This result should, however, be modified by Bethe's recent estimate of three-body cluster contributions, which reduces the short-range dispersive effect by a factor of 2 or 3. Consequently, the final discrepancy is back to the original 7 to 8 Mev. An attempt is made to reduce this discrepancy by replacing the hard core by a soft core and by improving the fit of the potential to the singlet S and D Livermore phase shifts. These lead to an increase in binding of $\approx 3\frac{1}{2}$ Mev in the singlet-even states. The situation in the other states is discussed briefly. A study of available calculational techniques shows that these are, in principle, good to 1 Mev or better, but in actual calculations additional approximations have to be introduced, thus causing greater errors. Some of these approximations are examined. The reference-spectrum method is applied to the ground state of light nuclei along lines suggested by Brandow, who defines a shell-model potential, which, besides the usual Hartree-Fock potential, has an additional "saturation" term. Finally, the calculation of shell-model effective interaction to be used in the calculation of nuclear spectra is considered within the framework of the BBG theory. Different calculational methods are reviewed, suggested, and studied. Numerical examples and comparison with results from other authors are offered. There appears to be rough agreement among different methods except for the following difficult matrix elements: the singlet-even states of high n (n = no. of nodes in the relative-coordinate wave function) and the triplet-even states. Preliminary results indicate that the BBG theory can reproduce qualitatively the range, approximate strength and the triplet- to singlet-S state ratio of empirical effective interactions, but that it gives too much short-range repulsion for the hard-core potentials investigated. (TCO)

34649 BETA AND GAMMA CIRCULAR POLARIZATION: ANGULAR CORRELATION ON ^{46}Sc AND ^{86}Rb. Wei, Ta-hsien. New York, Columbia Univ., 1964. 131p.

Thesis.

The β-γ circular polarization correlation in the decay of

^{46}Sc and ^{86}Rb was studied with a forward scattering cylindrical magnet. ^{60}Co (β^-) and ^{22}Na (β^+) of pure Gamow-Teller transitions were used to test the geometrical symmetry of the experimental set-up. The experimental set-up has several features essential for such precision measurements. One is the degaussing mechanism that enables the measurements to be taken at zero field of the scattering field as well as at the two saturated opposite fields. A spectrostat was also installed so that the high voltage on the γ photomultiplier was regulated to yield constant pulse height gain in spite of any small amplifier drift or temperature change. In order to eliminate any small uncertainties introduced by the time delay of the master switching mechanism, a 60-cycle timer was used to record the exact timing. The case of ^{46}Sc was studied in metallic scandium as well as in two chemicals, i.e., $ScCl_3$ and $Sc(OH)_3$. The asymmetry parameters observed in these three different chemical compositions of Sc are in good agreement with each other. The average asymmetry parameter of ^{46}Sc is $A = 0.076 \pm 0.010$, which implies that the Fermi matrix element is less than 1.5% of the G-T matrix element or the isotopic spin selection rule is valid in beta decay. The beta and gamma circular polarization angular correlation function for ^{86}Rb is $P(\theta_{\beta\gamma}) = (0.068 \pm 0.043)\ P_1(\cos\theta_{\beta\gamma}) - (0.276 \pm 0.077)\ P_3(\cos\theta_{\beta\gamma})$, if the beta and gamma angular correlation is taken as $W(\theta_{\beta\gamma}) = 1 + \bar{\epsilon}_2 P_2(\cos\theta_{\beta\gamma})$ where $\bar{\epsilon}_2 = 0.131$ is the anisotropy for an average electron energy of 313 kev. (Dissertation Abstr.)

34650 NUCLEAR REACTIONS LEADING TO ENERGY LEVELS OF ^{37}Ar AND ^{37}K. McNally, James Henry. Pasadena, Calif., California Inst. of Tech., 1966. 179p.

Thesis.

Information on some aspects of mass 37 nuclei was obtained using the ^{39}K(d,α)^{37}Ar and ^{35}Cl(^{3}He,p)^{37}Ar reactions. ^{37}Ar levels were found at 0, 1.41, 1.62, 2.22, 2.50, 2.80, 3.17, 3.27, 3.53, 3.61, 3.71, (3.75), (3.90), 3.94, 4.02, (4.21), 4.28, 4.32, 4.40, 4.45, 4.58, 4.63, 4.74, 4.89, 4.98, 5.05, 5.10, 5.13, 5.21, 5.35, 5.41, 5.44, 5.54, 5.58, 5.67, 5.77, and 5.85 Mev (the underlined values correspond to previously tabulated levels). The nuclear temperature calculated from the ^{37}Ar level density is 1.4 Mev. Angular distributions of the lowest six levels with the ^{39}K(d,α)^{37}Ar reaction at $E_d = 10$ Mev indicate a dominant direct interaction mechanism and the inapplicability of the $2I + 1$ rule of the statistical model. Comparison of the spectra obtained with the ^{39}K(d,α)^{37}Ar and ^{35}Cl(^{3}He,p)^{37}Ar reactions leads to the suggestion that the 5.13-Mev level is the $T = 3/2$ ^{37}Cl ground state analog. The ground state Q-value of the ^{40}Ca(p,α)^{37}K reaction was measured: -5179 ± 9 kev. This value implies a ^{37}K mass excess of -24804 ± 10 kev. Descriptions of a NMR magnetometer and a sixteen-detector array used in conjunction with a 61-cm double-focusing magnetic spectrometer are included. (Dissertation Abstr.)

34651 DECAY SCHEME OF ^{158}Tb. Schroeer, Dietrich. Columbus, Ohio, Ohio State Univ., 1965. 113p.

Thesis.

The decay of ^{158}Tb by electron capture to ^{158}Gd and by beta decay to ^{158}Dy was studied. Included are examinations of the individual transitions by means of beta and gamma scintillation detectors and a proportional counter, and studies of the cascades of transitions by means of these detectors in coincidence with another scintillation detector through fast-slow coincidence arrangements. Energies and intensities of transitions, cascades of radiations, lifetimes of states, and angular correlations were measured. Gamma-ray transition intensities (with total intensities in per cent of total ^{158}Tb decays) and electromagnetic character observed are 79.5 (93.0%; E2, M1 5%), 182 (13.9%), 782 (10.7%; E1, M2 1/4%), 922 (0.13%), 951 composite (68.9%), 1107 (2.31%; E2, M1 1%), 1188 (1.68%), 99.5 (13.0%), 219 (1.20%), 720 (0.35%), 236 (0.7%), 619 (0.7%), and 930 kev (0.10%). A decay scheme for the decay of ^{158}Tb was synthesized from these data, which is consistent with earlier decay schemes. Levels in ^{158}Gd established or confirmed are 79.5 (2^+; $T_{1/2} = 2.59$ ns), 261.5 (4^+; $T_{1/2} = 200$ ps), 1026 (2^-), 1044 (3^- K = 1 or 2), and 1188 kev (2^+, K = 2). Levels found in ^{158}Dy are 99.5 (2^+; $T_{1/2} = 1.79$ ns), 319 (4^+), and 819 kev ([$3^\pm$]; K = [0]). This decay scheme is compared with predictions of the unified nuclear model. The comparison indicated that both ^{158}Gd and ^{158}Dy conform to the picture of nuclei with large quadrupole deformations, though the latter deviates more in some of the rotational parameters. (Dissertation Abstr.)

34652 NEUTRON INELASTIC SCATTERING FROM IRON, COPPER, ZIRCONIUM, BARIUM, AND CERIUM. Tucker, Allen Brink. Stanford, Calif., Stanford Univ., 1965. 95p.

Thesis.

Cross sections for the production of excited states by neutron inelastic scattering were measured as a function of bombarding energy from 0–200 kev above threshold for the first two excited states of ^{56}Fe, the first two excited states of ^{63}Cu, the first excited state of ^{90}Zr, the first two excited states of ^{138}Ba, and the first three excited states of ^{140}Ce. Neutron beam energy resolution was 10–20 kev. Inelastic scattering events were counted by detecting gamma rays from the excited states. Results were compared with the Hauser-Feshbach theory, corrected for fluctuations of the compound nucleus level widths about their average values. This correction, evaluated by assuming a Porter-Thomas distribution of reduced widths, ranged from a 50% reduction to a 10% increase. Good agreement was found between measured cross sections and the modified Hauser-Feshbach theory in seven of the ten cases studied. (Dissertation Abstr.)

34653 RADIOACTIVITY OF ^{105}Cd. White, Richard Then. Columbus, Ohio, Ohio State Univ., 1965. 78p.

Thesis.

Sources of 57-minute ^{105}Cd were produced by the reactions ^{106}Cd(γ,n)^{105}Cd and ^{102}Pd(α,n)^{105}Cd. The ratio of the number of decays by orbital electron capture to the number of decays by positron emission was determined to be 2.4 ± 0.2. Spectra were accumulated by means of multichannel analyzers, sodium-iodide scintillation detectors, and a lithium-drifted germanium semiconductor detector. The following gamma transitions were observed: (intensities per 10^4 decays are indicated by numbers in parentheses) 83.5(2950), 347(1560), 433(755), 607(990), 877(300), 946 (960), 1310(1030), 1410(510), 1550(415), 1675(1100), 1900 (985), 2050(220), 2260(880) kev. The 946-, 607-, and 347-kev gamma rays are in cascade. On the basis of the above gamma-transition energies and probabilities as well as coincidence studies, a decay scheme for ^{105}Cd and an energy level diagram for ^{105}Ag are proposed. Experimental methods are discussed. (Dissertation Abstr.)

34654 SCATTERING OF NEUTRONS BY ALPHA PARTICLES. Hoop, Bernard Jr. Madison, Wis., Univ. of Wisconsin, 1966. 140p.

Thesis.

Differential cross sections for the elastic scattering of neutrons by alpha particles were measured at neutron bombarding energies between 8 and 31 Mev, using a recoil particle technique. A high-pressure helium gas scintillator was bombarded with monoenergetic neutrons, and the pulse height distribution of recoiling alpha particles was observed. This distribution is proportional to the center-of-mass angular distribution. Relative angular distributions were measured at about 2-Mev intervals over most of the energy range, and at about 50-kev intervals near 22 Mev. An attempt was made to fit the data with phase shifts. Phase shifts recently deduced from proton-alpha scattering in the energy range from 14 to 31 Mev were used over most of the energy range of the present experiment. These phase shifts include partial waves up to $l = 3$. They were adjusted for the Coulomb energy difference between the proton-alpha and neutron-alpha system by shifting the energy scale to bring the energy level in ^{5}He at 16.7-Mev excitation energy into coincidence with the corresponding level in ^{5}Li. In the neighborhood of the resonance near 22.16-Mev neutron energy, the adjusted proton-alpha phase shifts below the resonance were used, together with a $D_{3/2}$ resonant phase shift deduced from resonance parameters that describe the T(d,n)^{4}He reaction cross section. The proposed phase shifts fit the measured neutron-alpha dif-

ferential cross sections and the neutron total cross sections within the accuracy of the measurements up to 31 Mev, including the behavior at the 22.16-Mev resonance. These phase shifts also reproduce the measured angular variation of the asymmetry in the scattering of polarized neutrons by alpha particles. They can, therefore, be used to determine the polarization of neutrons from various sources. (Dissertation Abstr.)

34655 ELASTIC SCATTERING OF ^{3}He BY ^{16}O. Jin, Rong-sheng. Columbus, Ohio, Ohio State Univ., 1965. 110p.

Thesis.

The absolute differential cross section of elastic scattering of ^{3}He by ^{16}O was measured with a solid state detector in a differentially pumped gas scattering chamber. Five excitation curves were obtained at the scattering angles of 90, 125.3, 140.8, 149.5 and 167.2 degrees in the center-of-mass coordinate system. The incident energy of ^{3}He was varied from 2.7 to 4.0 Mev in steps of 15 kev. Fifteen angular distribution curves were obtained for theoretical analysis at specially chosen energies guided by the shape of the excitation curves. The theoretically calculated angular distribution curves were based upon the compound nucleus mechanism. The nuclear phase shifts that fit the angular distribution curves were presented. (Dissertation Abstr.)

34656 NUCLEAR STRUCTURE STUDY WITH NEUTRONS. Proceedings of the International Conference on the Study of Nuclear Structure with Neutrons, Antwerp, 19-23 July 1965. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Company, 1966. 596p. (CONF-650706).

Separate abstracts are prepared for 20 of the 21 papers presented. One paper was previously included in NSA as 19: 44157. (B.G.D.)

For abstracts of individual papers see: 34179, 34478, and 34657–34674.

34657 NUCLEAR MODELS. Mang, H. J. (Technische Hochschule, Munich). pp 26-33 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

A discussion is presented on the development and applications of nuclear models to the study of nuclear structure. Topics included are liquid drop and shell models, nuclear vibrations, nuclear rotations, and nuclear superfluidity (BCS-theory). (B.G.D.)

34658 (n, CHARGED PARTICLE) AND REVERSE REACTIONS. Weinberg, R. B. (Atomic Energy Research Establishment, Harwell, Eng.). pp 37-58 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

A discussion is presented on reaction mechanisms involving both charged particles and neutrons. The reactions discussed are those in which the mechanism is not important in extracting desired information, those in which an attempt is made to identify the mechanisms involved, and most important of all, the direct reaction to obtain specific information about various nuclei. (B.G.D.)

34659 INELASTIC NEUTRON SCATTERING. Ferguson, A. T. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 63-89 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

A discussion is presented on inelastic neutron scattering as a research tool for investigating nuclear structure and understanding nuclear reactions. The technical advances in this experimental technique are outlined. The interpretation of inelastic neutron scattering data is described. Some examples which show the power and range of this technique are included. (B.G.D.)

34660 SLOW NEUTRON CAPTURE GAMMA RAYS. Vervier, J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). pp 94-113 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

The thermal neutron capture γ-ray spectra which often contains a large number of lines in a wide energy range have decay schemes that are generally quite complex and include many levels in the product nucleus up to high excitation energy. The development of neutron capture γ-ray spectrometers, determination of the decay scheme, and interpretation of results from neutron capture γ-ray experiments which have led to overcoming difficulties in this field, and information on nuclear structure are discussed. (B.G.D.)

34661 QUASI-RESONANCES AND THE CHANNEL THEORY OF NEUTRON-INDUCED FISSION. Lynn, J. E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 125-49 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

The channel theory of neutron-induced fission is discussed. Topics included are characteristics of quasi-resonances, mixed resonances, and interpretation of data on slow neutron-induced fission. (B.G.D.)

34662 DETERMINATION OF NEUTRON RESONANCE PARAMETERS AND THEIR SIGNIFICANCE FOR NUCLEAR PHYSICS. Julien, J. (CEN, Saclay, France). pp 156-87 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

Methods of data analysis of neutron resonance parameters are discussed. The distribution of the different parameters (reduced neutron width, partial and total radiative width, and level spacings), correlation between parameters, and neutron strength functions (s and p wave) in connection with the average level spacing D and the average reduced neutron width are examined. The neutron resonance parameters are then applied to the investigation of the properties of nuclear energy levels. (B.G.D.)

34663 STRENGTH FUNCTIONS AND NUCLEAR SIZE. Newson, Henry W. (Duke Univ., Durham, N. C.). pp 195-215 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

A discussion is presented on neutron strength functions which includes three methods of estimation and examples of recent data. (B.G.D.)

34664 PRODUCTION OF AND EXPERIMENTS WITH POLARIZED NEUTRONS IN THE RESONANCE ENERGY REGION. Shapiro, F. L. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 223-35 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

The characteristics of a polarized proton target as a neutron polarizer are discussed and an experiment on determination of spins of neutron resonances of holmium is described. (B.G.D.)

34665 INVESTIGATIONS OF NEUTRON RESONANCES AND STRENGTH FUNCTIONS PERFORMED RECENTLY IN THE USSR AND JOINT INSTITUTE FOR NUCLEAR RESEARCH (DUBNA, U.S.S.R.). Malyshev, A. V. (Inst. of Physics and Energetics, Obninsk, USSR). pp 236-48 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

A survey is presented on the research work in the field of neutron spectroscopy which is carried out in several institutes of the U.S.S.R. and in the Joint Institute for Nuclear Research. Results of investigations related to parameters of isolated neutron resonances, strength functions, and average cross sections of nonfissionable and fissionable nuclei are included. (B.G.D.)

34666 DOORWAY STATES. Feshbach, H. (Massachusetts Inst. of Tech., Cambridge). pp 257-77 of Nu-

clear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

A discussion is presented on doorway states which are defined as constituents of the closed channel component of the wave function describing elastic scattering. In other words, the wave function ψ_d describes the closed channel amplitude excited directly from the open channel by the interaction. This discussion attempts to answer questions as to the consequences of their existence, conditions for observation, experiments performed, and what has been learned from them. (B.G.D.)

34667 CROSS-SECTION FLUCTUATIONS AND INTERMEDIATE STRUCTURE. Brink, D. M. (Oxford Univ.). pp 278-87 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

A discussion is presented on recent studies of the so-called Ericson statistical fluctuations in nuclear cross sections and those concerned with intermediate structure phenomena. (B.G.D.)

34668 STATISTICAL MODEL. Batchelor, R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 291-309 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

The application of the statistical model of the nucleus to nuclear reactions in which the states of the residual system form a continuum of levels similar to that assumed in the compound nucleus is discussed. The level density $W(E^*)$ of the residual nucleus where E^* is the excitation energy is considered. (B.G.D.)

34669 FAST NEUTRON CAPTURE REACTIONS. Starfelt, Nils (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 317-38 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

Fast neutron capture reactions are discussed. Topics included are capture cross sections relevant to element synthesis in stars and nuclear explosions, capture mechanisms (compound nuclear reactions, direct capture, collective capture, and interference between different reaction types), and the study of resonances and bound states including the problem of the multipolarity of capture γ rays. (B.G.D.)

34670 DIRECT RADIATIVE CAPTURE. Lane, A. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 343-58 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

An extension of the optical model is proposed to allow for capture proceeding through the excitation of collective vibrations (collective capture). Particle-vibration coupling which gives rise to inelastic scattering of incident particles is discussed. The theory of collective capture is presented. (B.G.D.)

34671 PHOTONEUTRON REACTIONS. Fuller, E. G. (National Bureau of Standards, Washington, D. C. Inst. for Theoretical Physics, Copenhagen). pp 359-75 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

A review is presented on the field of photonuclear reactions produced by real photons with particular emphasis being placed on neutron producing reactions. Three general features of the giant resonance are discussed. These are: the magnitude of the total interaction, the structure in the photon absorption cross section, and the decay of the giant resonance. (B.G.D.)

34672 EXPERIMENTS WITH POLARIZED PROTONS AND THE NEUTRON-NUCLEUS POTENTIAL DERIVED THEREFROM. Rosen, L. (Los Alamos Scientific Lab., N. Mex.). pp 379-417 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

The optical model is discussed in order to provide a proper description of nucleon-nucleus interactions. The analysis of polarization data by applying the optical model is stressed. (B.G.D.)

34673 OPTICAL MODEL. Perey, F. (Oak Ridge National Lab., Tenn.). pp 418-36 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

A discussion is presented on optical model analysis of small angle scattering of neutrons from nuclei. (B.G.D.)

34674 NEUTRON REACTIONS IN STARS. Reeves, H. (Univ., Montreal. Univ., Paris, Orsay, France). pp 451-7 of Nuclear Structure Study With Neutrons. Neve de Mevergnies, M.; Van Assche, P.; Vervier, J. (eds.). Amsterdam, North-Holland Publishing Co., 1966.

A discussion is presented on nucleosynthesis from neutron reactions in stars. The reactions are divided into two classes: the capture reactions in which the rate of capture of a particle by another one is much larger than the rate of photodisintegration of the subsequent compound nucleus and the equilibrium reactions in which the two rates are equal. (B.G.D.)

34675 NEUTRON PRODUCTION IN THICK TARGETS BOMBARDED BY HIGH ENERGY PROTONS. Fraser, J. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Green, R. E.; Hilborn, J. W.; Milton, J. C. D.; Gibson, W. A.; Gross, E. E.; Zucker, A. 9p. (CONF-650664-6). ORAU. Gmelin, AED-CONF-65-288-9.

From Canadian Association of Physicists Congress, Vancouver, B. C.

Some experiments are described which determine neutron yields from thick targets of Be, Pb, Sn, and depleted U bombarded by protons with energies from 0.5 to 2.0 Bev. These measurements were made to provide information for a study of an intense neutron generator based on a proton accelerator. (B.G.D.)

34676 OBSERVATION OF AN 8^+ LEVEL IN ^{20}Ne. Kuehner, J. A.; Ollerhead, R. W. (Chalk River Nuclear Labs., Ontario, Can.). 9p. (CONF-660107-33). ORAU. Gmelin, AED-CONF-66-003-62.

From American Physical Society Meeting, New York.

The discovery of an 8^+ level at 11.99 Mev excitation in ^{20}Ne is reported, and it is suggested that it is the missing member of the ground-state band. The resulting band has considerable distortion away from a rotation-like structure, and it is suggested that this results from pairing. (B.G.D.)

34677 IDENTIFICATION OF SPIN 3/2 AND 1/2 LEVELS IN ^{55}Fe. Earle, E. D.; Bartholomew, G. A. (Chalk River Nuclear Labs., Ontario, Can.). 12p. (CONF-660107-29). ORAU. Gmelin, AED-CONF-66-003-58.

From American Physical Society Meeting, New York.

The bound levels in ^{55}Fe are studied by examining the gamma rays emitted after thermal neutron capture in ^{54}Fe. (B.G.D.)

34678 LIFETIMES AND BRANCHING RATIOS OF LOW-LYING LEVELS OF ^{28}Si. Litherland, A. E.; Smulders, P. J. M.; Alexander, T. K. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 11p. (CONF-660107-20). ORAU. Gmelin, AED-CONF-66-003-26.

From American Physical Society Meeting, New York.

The SU(3) classification of the levels in the nuclear s-d shell has been very successful for several nuclei. This symmetry, as pointed out by Harvey, could result in a peculiar kind of collective motion in which the ^{28}Si nucleus is alternately prolate and oblate without passing through a region of spherical symmetry. The results of some recent experiments on ^{28}Si are described in order to provide evidence for the validity of this picture. (B.G.D.)

34679 β^+ TRANSITION TO FIRST EXCITED STATE IN ^{130}Xe. Galubman, M. J.; Kannenberg, S. L.; (Northeastern Univ., Boston). 6p. (CONF-651015-19). ORAU. Gmelin, AED-CONF-65-312-46.

It was found that the log ft value of the β^+ transition to the first excited state in ^{130}Xe is 6.1, using the 30-minute ^{130}Cs ground state activity. (auth)

34680 MEASUREMENT OF ELECTRON CAPTURE RATIOS AND INTERNAL CONVERSION COEFFICIENT RATIOS WITH A SOLID-STATE DETECTOR. Durosinmi-Etti, I. O.; Brundrit, D. R.; Sen, S. K. (Univ. of Manitoba, Winnipeg). 22p. (CONF-650664-5). ORAU. Gmelin, AED-CONF-65-288-7.

From Canadian Association of Physicists Congress, Vancouver, B. C.

A recently developed coincidence technique, employing a solid state detector, for the measurement of the ratios of internal conversion coefficients, has been used to measure the ratios of K-electron to the total electron capture in ^{113}Sn and ^{109}Cd. The ratios, P_{LM}/P_K, of electron capture from shells higher than K to capture from the K shell have been determined from the above measurements to be 0.16 ± 0.02 for ^{113}Sn and 0.26 ± 0.04 for ^{109}Cd yielding the electron capture transition energies of 280^{+340}_{-100} kev and 83^{+31}_{-12} kev respectively. The method relies upon the coincidence between a conversion electron from the intermediate level formed by electron capture and the x ray accompanying the conversion electron, and gives the values of capture ratios independent of fluorescence yield, x ray detection efficiency, and absorption of x rays in the source and in the detector shielding materials. The K/(L + M) internal conversion coefficient ratios for the 393 kev transition of ^{113m}In and for the 88 kev transition of ^{109m}Ag have been measured to be 4.5 ± 0.1 and 0.83 ± 0.02 respectively. (auth)

34681 NEUTRON SCATTERING FROM NITROGEN. Fowler, J. L.; Johnson, C. H. 10p. (CONF-651135-2). ORAU. Gmelin, AED-CONF-65-402-2.

From American Physical Society, Southeastern Section, Charlottesville, Va.

Experimental results are presented on elastic differential scattering of neutrons by ^{14}N at 1.595 to 3.25 Mev. Angular momentum and parity assignments are given for the resonances identified. (B.G.D.)

34682 METHOD OF APPLYING COMPTON SCATTERED NEUTRON CAPTURE RADIATION TO NUCLEAR PHOTO-EXCITATION. Knowles, J. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 17p. (CONF-650664-3). ORAU. Gmelin, AED-CONF-65-288-1.

From Canadian Association of Physicists Congress, Vancouver, B. C.

The source of γ radiation consists of plates of titanium and nickel placed in an NRU beam tube. Characteristic (n,γ) radiations, in particular the 1.37- and 6.75-Mev γ rays of ^{49}Ti and the 8.99-Mev γ rays of ^{59}Ni are Compton scattered from a curved aluminum plate placed outside the reactor. The geometry is arranged so that scattered radiation of one energy converges to a narrow beam at the position of the target. The energy of the convergent radiation is varied by moving the target to different angular positions with respect to the aluminum scatterer. The energy range is 0.1 to 8.5 Mev and energy selection 1 to 3% The incident beam intensity is 1 to 10 quanta ev^{-1} cm^{-2} sec^{-1}. By varying the γ-ray beam energy between 6 and 8 Mev with approximately 2% energy selection the elastic scattering and self-absorption of radiation from a target of natural lead was measured. The elastically scattered radiation, detected by a NaI(Tl) scintillator at a mean scattering angle of 135°, shows intensity maxima corresponding to γ-ray transitions in lead at 6.6, 6.9, and 7.2 Mev. The elastic scattering results averaged over the 3 transitions give an integrated cross-section over the energy width of the incident γ-ray beam of $(4 \pm 2) \times 10^3$ barns ev which can be interpreted to yield a total width for nuclear resonance scattering of 70 ± 30 ev. The self-absorption results give an average effective nuclear absorption cross-section for the 3 transitions in natural lead of 18 ± 5 barns. (auth)

34683 INFORMATION ON SPINS AND PARITIES OF NUCLEAR LEVELS FROM INELASTIC ELECTRON SCATTERING. Onley, David S. (Ohio Univ., Athens). 9p. (CONF-651118-15). ORAU. Gmelin, AED-CONF-65-329-15.

From American Physical Society, Gatlinburg, Tenn.

Inelastic scattering of electrons by nuclei, which give rise to nuclear excitation is investigated in order to determine to what extent the general behavior of the form factors depend on the gross features of the transition (on changes in angular momentum, parity, energy) of the nuclear state. (B.G.D.)

34684 WEAK CROSS-OVER TRANSITIONS FROM THE 7.02- AND 4.97-Mev LEVELS IN ^{20}Ne. Alexander, T. K.; Broude, C.; Litherland, A. E.; Ollerhead, R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 13p. (CONF-650664-1). ORAU. Gmelin, AED-CONF-65-288-3.

From Canadian Association of Physicists Congress, Vancouver, B. C.

Using the $^{12}C(^{12}C,\alpha\gamma)^{20}Ne$ reaction an enhanced E3 gamma-ray transition has been reported from the 5.63-Mev (3^-) state to the ground state (0^+) in ^{20}Ne, and its relevance in the interpretation of the structure of the ^{20}Ne discussed. Using the same reaction with improved sensitivity, the intensities of the weak M2E3 transition from the 7.02 Mev (4^-) state to the 1.63-Mev (2^+) state and the M2 transition from the 4.97-Mev (2^-) state to the ground state were obtained. The 7.02-Mev level decays (60%) by E2 radiation to the 4.97-Mev state, which in turn decays almost entirely by E1 radiation through the 1.63-Mev state. Present measurements yield the intensity of the 7.02−1.63 transition to be 0.75% of this E1 transition. The intensity of the M2 transition from the 4.97-Mev state to the ground state is 0.5% of the branch to the 1.63-Mev state. The present measurements combined with lifetime measurements give $|M|^2 \lesssim 6$ Wu (Weisskopf unit) for the enhancement of 4^- to 2^+ E3 transition from the 7.02-Mev state and $|M|^2 = 2$ mWu for the 2^- to 0^+ M2 transition from the 4.97-Mev state. (auth)

34685 INTERNAL-CONVERSION STUDIES OF TRANSITIONS IN ^{133}Cs. Hennecke, H. J. (Aerospace Research Labs., Wright-Patterson AFB, Ohio); Manthuruthil, J. C.; Bergman, O.; Cothern, C. R. 9p. (CONF-660107-16). ORAU. Gmelin, AED-CONF-66-003-41.

From American Physical Society Meeting, New York.

Results of energy and momentum measurements of the internal conversion electron lines corresponding to nine possible transitions in the decay scheme of ^{133}Cs between the 5 states populated in the electron capture decay of ^{133}Ba are discussed. (B.G.D.)

34686 REACTIONS ^{9}Be(^{3}He,T)^{9}B AND ^{9}Be(^{3}He,^{3}He)^{9}Be. Earwaker, L. G. (California Inst. of Tech., Pasadena). 10p. (CONF-651213-3). ORAU. Gmelin, AED-CONF-65-400-4.

From American Physical Society, Winter Meeting in the West, Los Angeles.

The ^{9}Be(He-3,T)^{9}B and ^{9}Be(He-3,He-3)^{9}Be reactions are examined in order to determine the applicability of Lane's optical model approach in light nuclei. (B.G.D.)

34687 ELASTIC AND INELASTIC SCATTERING OF 14 Mev NEUTRONS FROM Ni AND Zr. Clarke, R. L.; Cross, W. G. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 7p. (CONF-650664-4). ORAU. Gmelin, AED-CONF-65-288-6.

From Canadian Association of Physicists Congress, Vancouver, B. C.

Measurements of the cross sections for the lowest 2^+ in Ni and lowest 2^+ and 3^- states in Zr from elastic and inelastic scattering of 14-Mev neutrons are obtained. Nuclear distortion parameters are compared with those obtained by other methods. (B.G.D.)

34688 METHOD FOR DETERMINATION OF ALPHA EMITTERS EMITTING SIMULTANEOUSLY X RAYS SUCH AS ^{239}Pu IN THE PRESENCE OF BACKGROUND RADIATION. Kiefer, Hans; Maushart, Rupprecht (to Gesell-

schaft fuer Kernforschung mbH). German Patent 1,214,330. Apr. 14, 1966. Filed Oct. 25, 1962.

Method for determination of alpha emitters emitting simultaneously x rays, such as ^{239}Pu, in the presence of background radiation. The method comprises the detection of the coincidence of two types of pulses, one type of which is obtained from a known alpha detector and the other type of which is obtained from a known x-ray detector. (Gmelin Inst.)

34689 DEVICE FOR PRODUCTION OF NUCLEAR REACTIONS ON AN IMPACT ELECTRODE (TARGET), ESPECIALLY NEUTRON FLASH TUBES. Schmidt, Albrecht (to Gesellschaft fuer Kernforschung mbH). German Patent 1,214,331. Apr. 14, 1966. Filed Jan. 9, 1963.

The neutron flash tube according to patent 1,206,095 comprising two electrodes concentrically and axial-symmetrically opposed to each other one of which is the impact electrode (target) is improved in that the spherical impact electrode encloses the gas discharge region nearly entirely. (auth)

Plasma Physics and Thermonuclear Processes

See also Fluid Physics and Thermodynamics

Refer also to abstracts 34095 and 34349.

34690 (AD-634274) PARAMETRIC EFFECTS OF RADIATION ON A PLASMA. Jackson, E. Atlee (Illinois Univ., Urbana. Coordinated Science Lab.). June 1966. Contract DA-28-043-AMC-00073(E). 37p. (R-298). CFSTI $2.00 cy, $0.50 mn.

The parametric excitation of the modes of an infinite plasma by intense incident radiation is studied on the basis of the Vlasov equation. It is found that the modes can be driven into unstable oscillations for incident frequencies in the three regions $\omega_0 \simeq \omega_{pe}$, $\omega_{pe} + \omega_i$, and $2\,\omega_{pe}$, where ω_{pe} is the electron plasma frequency, and ω_i is the ion acoustic frequency. In the limit of weak intensities, the features of the two resonances $\omega_0 \simeq \omega_{pe} + \omega_i$ and $2\,\omega_{pe}$ are found to be in substantial agreement with the results of DuBois and Goldman. For larger intensities it is found that the resonance $\omega_0 \simeq \omega_{pe} + \omega_i$ is restricted to frequencies, ω_0, which are not more than 4 ω_{pi} above this value, and have a maximum growth rate of .05 ω_{pe}. The resonance near $\omega_0 \simeq \omega_{pe}$ is found to be dominated by collisional damping if $(\gamma/\omega_{pe}) > 10^{-4}$, and limited to a range of frequencies ω_0 of only $\omega_{pi}/100$. The present results, for large intensities, only partially agree with the results obtained by Silin, who only studied one of the present resonances. These results indicate that the usual harmonic approximation for the plasma is not justified in the study of optical mixing. (auth)

34691 (AD-634596) THEORY OF SPHERICAL AND CYLINDRICAL LANGMUIR PROBES IN A COLLISIONLESS, MAXWELLIAN PLASMA AT REST. Laframboise, James G. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Mar. 1966. 209p. (UTIAS-100). CFSTI $6.00 cy, $1.25 mn.

A method was developed and used to obtain theoretical predictions of the current collected from a collisionless, fully Maxwellian plasma at rest by an electrically conducting Langmuir probe having spherical or cylindrical symmetry. The probe characteristic, or functional relation between current and probe potential, was determined for both geometries for probe radii up to 100 times the Debye shielding distance of the hotter species of charged particle, for a complete range of ion-to-electron temperature ratios, and for probe potentials from −25 to +25 times the thermal energy of the hotter species. Each current collection result is computed to a relative accuracy of 0.002 or better in an average time of approximately two minutes on the IBM 7094. Maxwellian velocity distributions and finite current collection are assumed for both ions and electrons. The infinite plasma is replaced by an outer boundary at a finite radius, beyond which a power-law potential is specified. The resulting nonlinear system of integral equations is solved by an iterative numerical scheme which incorporates an extension of the Bernstein and Rabinowitz method to provide charge densities for ions and electrons. No a priori separation into sheath and quasi-neutral regions is assumed. Explicit comparison is made between the results for a completely Maxwellian plasma and those for a plasma mono-energetic in attracted particles, as treated by Bernstein and Rabinowitz, Lam, and Chen. It is shown that in certain cases, the mono-energetic plasma does not adequately simulate the Maxwellian plasma. It is also shown that difficulties encountered by Berstein and Rabinowitz in computing the ion current for the cylinder in the zero-ion-temperature limit are illusory, and that the computations of Chen for this case do not take into account the fact that the ion temperature acts as a singular perturbation. Computed charge density and potential functions are presented graphically. Computed probe characteristics are presented in graphical and tabular form. A listing is included of the Fortran programs used to obtain these results. (auth)

34692 (IPP-4/26) NEW FAST CAPACITOR BANKS FOR THETA-PINCH EXPERIMENTS AT THE INSTITUT FUER PLASMAPHYSIK IN GARCHING. Fertl, K. H.; Herppich, G.; Knobloch, A.; Schlageter, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr. 1966. 20p. (CONF-660530-7). Dep. mn.

From 4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy.

Three lumped parameter capacitor banks of different stored energies are described. The approximate data are 10 kJ/400 kHz, 500 kJ/100 kHz, and 2.6 MJ/25 kHz, all at 40 kv charging voltage. The 400 kHz- and 100 kHz-banks are being mounted at present and will be ready for operation this summer and towards the end of this year. Both will be connected to symmetrically double-fed linear coils; this series connection gives rise to a higher discharge frequency. Special features of the first two banks are the collector-system, which at the 500 kJ-bank permits alternatively feeding of a toroidal experiment with minimum replacement of components, the use of impulse cable plug contacts and a peculiar coil arrangement for the bias field at the 10 kJ-bank. The 2.6 MJ-bank "Isar I" has now been in operation at 1.5 MJ (30 kV) more than one year without considerable technical difficulties. About 3000 discharges including those with partial energy were made. The bank will be prepared for crowbar operation this summer. In addition the collector will be extended in order to improve the flux density distribution in the coil. (auth)

34693 (IPP-4/27) STEEP VOLTAGE TRIGGERING OF A SIMPLE TWO-ELECTRODE CROWBAR GAP. Gruber, Jos.; Mueller, Gerh. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug. 1965. 21p. (CONF-660530-4). Dep. mn.

From 4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy.

The principle of triggering a simple two electrode crowbar-gap working under atmospheric pressure is discussed. By means of a low impedance 100 kv trigger generator reliable triggering in a testcircuit was achieved, giving a 44 kv, 20 nsec rise, pulse at the crowbargap. The inherent jitter of the crowbargap was found to be only 0.5 nsec, though the overall jitter of the trigger system was 20 nsec. The gap passed a current of 60 kA when the capacitor unit was charged to 30 kv. (auth)

34694 (IPP-4/28) COMBINED START AND CROWBAR SPARKGAP WITH WIDE OPERATING RANGE. Haeglsperger, H.; Klement, G.; Kunze, R. C.; Mueller, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr. 1966. 29p. (CONF-660530-5). Dep. mn.

From 4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy.

A sparkgap and its triggering mode are described having

an operating range of 1:5 with a jitter of mainly less than 20 ns within the range. The gap ratio and the electrode geometry relative to earth are unsymmetrical. Using these principles the development and characteristics of an open, normal pressure coaxial and a pressurized, parallel plate transmission line start and crowbar switch unit of small dimensions are reported. In both cases the crowbar gap is of the ferrite decoupled type. Also the start and crowbar gaps are moulded together in a chamber formed by an epoxy resin insulation. Experience in operation, life test data and development is given. (auth)

34695 (IPP–4/29) AN ANALOG SYSTEM FOR THE DESIGN OF SWITCHED DISCHARGE CIRCUITS IN PLASMA PHYSICS. Herppich, G.; Knobloch, A. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr. 1966. 23p. (CONF-660530–8). Dep. mn.

From 4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy.

In designing pulse discharge circuits it is necessary to have a cheap and quick method of checking the computed data. This is afforded by the switching circuit analog system. A method was devised in which the ordinary switches, i.e., spark gaps or ignitrons of the original arrangement, are replaced by mercury-wetted contacts. These are operated by a program controlled system with special terminal amplifiers. The program controlled system enables the switches to be delayed from 0 ... 1000 μs. With the aid of the special terminal amplifiers the jitter of the relay is limited to ±300 ns. With a linear impedance transformation the real and distributed electrical values will be transformed in such order of magnitudes that they can be easily maintained and adjusted. The models are operated at low voltage. The model investigations are carried out mainly in original time scale. In investigating circuits with transit time effects, this approach has the advantage of allowing original components (e.g., cables or sandwich conductors) to be used. The capacitor-bank models are set up quickly and conveniently by means of pin boards designed for this purpose. These enable a maximum of six batteries in crowbar operation to be plugged in. In the case of single-switch models it is possible with a sampling oscilloscope to obtain unique and rapid actions on the screen in the form of steady images. (auth)

34696 (IPP–4/30) GEOMETRIC HIGH-FREQUENCY MODELS AND POTENTIAL ANALOGS FOR THE DETERMINATION OF CURRENT AND FIELD DISTRIBUTIONS. Knobloch, A.; Mantel, J.; Roos, G.; Schlageter, H.; Werner, F. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1966. 57p. (CONF-660530–6). Dep. mn.

From 4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy.

For the choice of electrical and other data for fast capacitor banks used for experiments in plasma physics the project engineer uses observations and measurements made on appropriate models. The models of various collector and load configurations and the measurements made on them are described. (auth)

34697 (IPP–4/32) FERRITE DECOUPLED CROWBAR SPARKGAP. Kunze, R.-C.; Mark, E. v.; Wedler, H.; Klement, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr. 1966. 39p. (CONF-660530–10). Dep. mn.

From 4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy.

The principle of decoupling a crowbar gap using saturable ferrite was further improved and the trigger mechanism for three switches explained. The design of the first sparkgap is very simple, using a pulse pre-magnetization, an increase in the available decoupled voltage is achieved. This sparkgap was tested for more than 8000 discharges in a circuit using two units of the 2.6 MJ bank. The second crowbar switch which also works by the principle of ferrite decoupling, was developed for a 150 kJ bank. Using a third electrode, ⅔ of the ferrite cores can be saved. This electrode is a metal point which for static and dynamic conditions lies at the half potential. The crowbar trigger pulse applied to the point increases the electric field which results in a very early and jitter-free ignition to the main electrode. The third switch workd without ferrite decoupling. The middle electrode, which is a cone shaped electrode as in switch II, breaks down at the same time to both main electrodes. This is possible, because the trigger pulse on the middle electrode is sharpened through a pulse sharpening gap. (auth)

34698 (IPP–4/34) A GIANT PULSE LASER WITH A TRIGGERABLE PASSIVE Q-SWITCH PERFORMANCE. Maischberger, K. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1966. 15p. (CONF-660530–3). Dep. mn.

From 4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy.

A method of Ruby Laser operation is described which produces fast, intense and triggerable giant laser pulses by Q-switching with a selective saturable organic dye. The Ruby rod ⅝ inch in diameter and 7 inches long is used in an ellipsoid pump configuration. The passive Q-switch element is placed between the 90-deg rod with a TIR chisel and a separate end mirror. A double-pulse circuit energizes a linear flash tube. A pre-ionizing pulse fires the main capacitor bank. After a suitable delay a second trigger signal switches the energy of a 8-μF capacitor (E_{max} = 450 Joules) to the flash tube load. This short high-power pulse, now not current limited, will start laser action corresponding to the second trigger signal on conditions which are discussed. The jitter relative to the second trigger signal, the energy and power output of the resulting giant pulses is described. (auth)

34699 (IPP–4/36) LOGARITHMIC D-C AMPLIFIER WITH EARTH-ISOLATED INPUT. Skerjanc, F. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr. 1966. 12p. (CONF-660530–2). Dep. mn.

From 4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy.

In order to observe the current of an earth-isolated double-probe on the plasma-column, an intermediate stage amplifier was built which enabled the survey of d-c-current in the range of 10^{-5} and 10^{-9} A in logarithmic scale on a grounded oscilloscope. The earth-isolation of the measuring probe is guaranteed with R = 10^{12} Ω, C = 15 pf. This amplifier also can be adapted for other linear measurements on objects which ask for a potential separation towards the grounded oscilloscope. (auth)

34700 (IPP–4/37) TRANSIENT VOLTAGE DECOUPLING ELEMENTS. Gruber, J. E. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr. 1966. 23p. (CONF-660530–1). Dep. mn.

From 4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy.

Voltage transients which enter trigger-circuits may cause premature or unexact timing in Thyratron generators. Decoupling elements such as spark gaps can prevent these effects, if connected in the output line of the generator. Different types of spark gaps were investigated with respect to their pulse breakdown voltage and jitter. A very simple construction of a two electrode gap, with corona illumination gave lowest jitter of only ±0.5 nsec. Some of commercial available protective spark gaps also show appreciable low jitter. Both types can be used in decoupling of voltage transients. (auth)

34701 (MATT–353) PLASMA OSCILLATIONS AT HARMONICS OF THE ION GYROFREQUENCY. D'Angelo, N.; Goeler, S. v.; Levine, A. (Princeton Univ., N. J. Plasma Physics Lab.). Aug. 1965. Contract AT(30-1)-1238. 7p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The observation of oscillations with $\omega \approx m\omega_i$ (m = 1, 2, 3, 4, 5), where ω_i is the ion gyrofrequency is reported. Several harmonics of the ion gyrofrequency were observed. Excitation of the different harmonics appears to require a ratio $v_{e,drift}/v_{i,th}$ comparable to that required for the excitation of the fundamental frequency. The dependence of the oscillation frequency on the confining magnetic field for m = 1, 2, 3 is shown, and it is found in general that higher modes are excited at higher values of B. (J.F.P.)

34702 (N-65-34392) EXPERIMENTAL INVESTIGATION OF THE FUNDAMENTAL MODES OF A COLLISIONLESS PLASMA. Annual Summary Report, March 10, 1964–March 31, 1965. Book, David L.; Malmberg, John H.; Wharton, Charles B. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). May 17, 1965. Contract NAS7-275. 41p. (NASA-CR-67099; GA-6335).

The dispersion relations for the electrostatic waves in collisionless plasma were measured near the electron cyclotron frequency. Several waves are observed, including the C_{01} backward wave between the cyclotron frequency and the upper hybrid frequency and the plasma perturbed $T_{e||}$ wave guide mode. The cyclotron waves are heavily damped. The Landau damping of the electrostatic modes of a plasma with finite radial dimensions is investigated theoretically. The growth of these electrostatic modes due to a beam whose energy depends on radius is also calculated. (auth)

34703 (N-66-12483) RAPPORT ANNUEL DU LABORATOIRE DE PHYSIQUE DES PLASMAS. (Plasma Physics Laboratory Annual Report. (Montreal Univ. (Quebec). Dept. of Physics). Oct. 1965. 56p. CFSTI $3.00 cy, $0.50 mn.

Several research projects are described which deal with the development of laboratory tools for studying plasmas with negative ions such as single and double probes and the radio frequency probe. Each project is closely connected with a parallel theoretical study. The studies of plasmas with negative ions also include an experiment on the Townsend ionization and attachment coefficients in mixtures of chlorine and argon. A study of diffusion of charges in a plasma containing negative ions is also being conducted. A project is in progress to measure the structure and motion of striations in a gas discharge by microwave techniques. A theoretical study is being conducted on the Tonk-Dattner resonances. A basic study was undertaken to determine the electromagnetic properties of a plasma in the presence of negative ions. A project on the development of a radio frequency velocity selector for electrons is also in progress and experiments are being conducted with an electron gun to establish the performance of this probe. (STAR)

34704 (N-66-14955) TRANSMISSION AND REFLECTION OF ELECTROMAGNETIC WAVES NORMALLY INCIDENT ON A WARM PLASMA. Scientific Report No. 257. Comstock, Craig (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Dec. 10, 1965. 33p. (NASA-CR-69208). CFSTI $2.00 cy, $0.50 mn.

The solution for an electric field normally incident onto a warm, semi-infinite plasma is obtained by means of a modified Wiener-Hopf technique. The warm plasma is taken into account by means of the relativistic Vlasov equation. It is found that the previously obtained solution of Taylor gives the correct term for the wave number in the plasma, but not the correct answer for the field. It is shown that the method of considering an equivalent fully infinite plasma corresponds to a physically unrealistic matching of the plasma to the vacuum. The field inside the plasma and in the vacuum is found. The field just inside the plasma is obtained, and the non-uniform limit from warm to cold plasma found by Taylor is not found in our solution. (auth)

34705 (N-66-16598) CHARACTERISTICS OF MAGNETOPLASMAS. Semiannual Status Report No. 12, May 1–October 31, 1965. Holt, E. H.; Hollinger, H. B.; Huchital, D. A.; Blaszuk, P.; Pan, P. N. Y. (Rensselaer Polytechnic Inst., Troy, N. Y. Plasma Research Lab.). Dec. 1965. 27p. (NASA-CR-70151). CFSTI $2.00 cy, $0.50 mn.

Emphasis was on the study of the Kadomtsev instability which pertains to the behavior of a collision dominated plasma in a magnetic field. Work on this instability in the positive column of an electrical discharge in helium has extended previous results to include the effect of a transverse component of the magnetic field. The Kadomtsev theory was successfully modified to account for the major features of the experimental results. A further aspect of plasma transport phenomena was studied. This concerns the initial value aspects of the conduction of heat in a plasma and follows the previous studies dealing with plasma diffusion from this point of view. A study of the non-Maxwellian form of the electron velocity distribution function in the nitrogen afterglow plasma is reported. This work was done by combining the use of the magneto-plasma waveguide cell with the gated microwave radiometer. The major features of the distribution function in the early afterglow were revealed. The apparently anomalous behavior of the electron gas in the nitrogen afterglow was explained. Design, construction, and the taking of preliminary performance data for various parts of the cesium plasma cell has proceeded. The filament and hot plate structures were constructed and operated. The design of the probes and the cesium ovens and details of the complete assembly are described. (auth)

34706 (N-66-16719) WING-SLOPE TECHNIQUES FOR THE ANALYSIS OF LANGMUIR PROBE CHARACTERISTICS. Bettinger, Richard T. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Aug. 1965. 28p. (NASA-CR-70018). CFSTI $2.00 cy, $0.50 mn.

The volt-ampere characteristics of Langmuir probes employing ideal geometries (spherical or cylindrical) contain a considerable amount of information, much of which is not utilized in the usual analysis programs. The slopes of the V-i curve for large accelerating potentials contain a substantial amount of information on mass density and temperature. Equations were developed for the current and its slope in this region for both of the above geometries and applied to a few typical situations. The usefulness of Langmuir probe techniques may be appreciably improved by performing a total analysis on the available information. In some cases, measuring the slopes directly will supply the same information with a substantial saving in experimental complexity. (auth)

34707 (N-66-17095) NONLINEAR RESPONSE OF AN OSCILLATING DISCHARGE TO VERY HIGH-FREQUENCY SIGNALS. Technical Report No. 3, June 1963–August 1965. Raiford, D. B. (College of William and Mary, Williamsburg, Va. Plasma Physics Lab.). 47p. (NASA-CR-70323). CFSTI $2.00 cy, $0.50 mn.

Thesis.

A general discussion of the appearance of nonlinearities in the governing equations for the behavior of a plasma is presented. A historical survey of nonlinearities in plasmas and their observation and description by earlier investigators is discussed in an effort to achieve a basic foundation for the subsequent presentation. Experimental apparatus used to produce and investigate nonlinearities in an oscillating discharge was assembled. A very high frequency signal applied to the anode of the discharge affects the direct current drawn by the discharge. This effect appears as a resonant change in the dc level near frequencies characteristic of the oscillating discharge. A quadratic dependence of the response on the applied signal level indicates a second-order nonlinearity. These nonlinear effects are observed only when the frequencies involved correspond to the characteristic modes of the system. (auth)

34708 (NASA-TM-X-1251) OPTIMIZATION OF ADIABATIC MAGNETIC MIRROR FIELDS FOR CONTROLLED FUSION RESEARCH. Roth, J. Reece (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). July 1966. 39p. CFSTI $2.00 cy, $0.50 mn.

Guidelines for the design of magnetic mirror machines used in controlled fusion research apparatus are formulated. Scaling relations, derived for both conventional and superconducting coils, relate the cost of the coils to the coil dimensions and the magnetic field strength produced by the coil. Such a scaling law for superconducting solenoids was derived from data on 98 superconducting coils that have been sold commercially. It is shown that under many conditions, including conventional water-cooled copper coils, there exists no optimum design, and the total number of adiabatically confined particles is just proportional to the amount of capital one can invest in the magnetic field coils. For superconducting coils,

however, there exist optimum values of the magnetic field strength, coil dimensions, and mirror ratio for which the number of adiabatically confined particles per dollar of investment in the coils will be a maximum. For superconducting coils, the optimum mirror ratios lie between the high values $1.00 \leq B_{min}/B_{max} \leq 0.95$. This optimum mirror ratio is relatively insensitive to the scaling law parameters for magnet cost, provided that superconducting coils are under discussion. This high optimum mirror ratio, and the other guidelines developed are not qualitatively dependent on the cost of superconducting coils at any given time. (auth)

34709 (UCRL-14279) ALTERNATING-GRADIENT FOCUSING OF RELATIVISTIC ELECTRON COILS. Christofilos, N. C. (Lawrence Radiation Lab., Univ. of California, Livermore). June 23, 1965. Contract W-7405-eng-48. 13p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

In order to confine plasma within relativistic electron coil (as Astron E-layer), it is necessary to support these coils with an external vacuum field. If it is desired to support electron coils of arbitrary length, a vacuum field configuration is required which present to the electrons, traveling parallel to the axis of the electron coil, an alternating field gradient. Theories are derived for the field index in an alternating gradient field and the precession of the E-layer in a non-axisymmetric field. (M.O.W.)

34710 (UCRL-14282) EXPERIMENTAL STUDY OF THE PROPERTIES OF RELATIVISTIC ELECTRON COILS IN THE ASTRON. Christofilos, N. C.; Briggs, R. J.; Hester, R. E.; Lauer, E. J.; Weiss, P. B. (Lawrence Radiation Lab., Univ. of California, Livermore). June 23, 1965. Contract W-7405-eng-48. 11p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Various properties of the Astron E-layer are described. They are as follows: trapped electron current and lifetime of the E-layer, precessional oscillation of the E-layer, and the backward precession of the E-layer confined in an alternating gradient field. (M.O.W.)

34711 (AD-630972) INVESTIGATION OF THE MOTION OF A PLASMA IN A GAS-DISCHARGE TUBE EQUIPPED WITH COAXIAL ELECTRODES. Chekalin, E. K.; Trukhin, V. I.; Lozinskaya, A. I. Translated from pp 59-72 of Fizicheskaya Gazodinamika Svoistva Gazov Pri Vysokikh Temperaturakh, 1964. 27p. (FTD-TT-65-1890). CFSTI $2.00 cy, $0.50 mn.

Coaxial electrodes were used as the plasma accelerator. The distribution of velocities of the forward glowing front of the plasma was investigated inside a coaxial accelerator with a wide range of initial air pressures in the tube. Observations were conducted on the outflow of plasma from the coaxial accelerator and the reflection of plasma from the face of the tube. Time-dependent recordings were taken of the impulse of pressure on the face of the tube and the glow of the plasma. The spectral composition of the plasma was also investigated. (M.O.W.)

34712 ELECTRICAL CONDUCTIVITY OF PARTIALLY IONIZED GASES. Schweitzer, S.; Mitchner, M. (Stanford Univ., Calif.). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1012-19(June 1966).

A simplification of the Chapman-Enskog method for the calculation of the electric conductivity of a multicomponent partially ionized gas in a magnetic field is presented based on the small electron mass. The calculation requires the inversion of a matrix, which is of the order of the approximation and is independent of the number of species. The third approximation to the electric conductivity is examined for an electron-ion-neutral plasma and the results are compared with those obtained from the mixture rules of Lin, Resler, and Kantrowitz, and of Frost. It is shown that within the uncertainties in the experimental electron-neutral cross-section values, Frost's formula offers a satisfactory method of calculation for most engineering applications. (auth)

34713 MEASUREMENT OF THE VELOCITY DISTRIBUTION IN A PLASMA JET. Gottschlich, Chad F. (Univ. of Pennsylvania, Philadelphia). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1085-7(June 1966).

Spectroscopic measurements of the temperature distribution in a laminar plasma jet are used together with the energy equation to deduce the velocity distribution in the jet. This method has the advantage of not disturbing the flow and of having excellent spatial resolution. (B.G.D.)

34714 FLOW TRANSITION PHENOMENA IN A SUBSONIC PLASMA JET. Incropera, Frank; Leppert, George (Stanford Univ., Calif.). Contract AT(04-3)-247. AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1087-8(June 1966).

A method is presented in which the three flow regimes (laminar, transitional, and turbulent) of plasma jets can be determined from measurements of jet noise level and mixing lengths and described in terms of a Reynolds number, which is based on bulk fluid properties. (B.G.D.)

34715 ANALYTICAL SOLUTION FOR MINIMUM LENGTH MHD ACCELERATOR WITH CONSTANT PRESSURE. Fiorini, Vittorio (Centro Ricerche Aerospaziali, Rome). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1098-1100(June 1966).

A minimum length solution for the constant pressure accelerator is presented, which allows both conductivity and magnetic field variations along the axis on the basis of one-dimensional gas-dynamics and the calculus of variations. (B.G.D.)

34716 COMPUTATION OF ELECTROSTATIC PROBE CHARACTERISTICS BY QUASILINEARIZATION. Radbill, John R. (North American Aviation Inc., Downey, Calif.). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1195-1200 (July 1966).

The numerical solution of a mathematical model of a spherical electrostatic probe in a collision-dominated partially ionized gas and the application of this solution to reduction of probe data gathered from a small hot-shot wind tunnel are described. In the simple plasma model considered, ionization and recombination are neglected, and current is assumed to flow between the probe and infinity. This mathematical model leads to a sixth-order nonlinear system of ordinary differential equations with two-point boundary conditions. An asymptotic quasineutral solution is used as an initial condition for a solution by quasilinearization. Distribution of charge carrier densities and potentials are presented for several values of dimensionless probe potential and radius, and one case is presented where the ion and electron temperature are not equal. Dimensionless current-voltage curves are presented for a range of dimensionless probe sizes for singly charged ions and equal electron and ion temperatures. A method is developed for analyzing experimental probe data using the numerical solution results. (auth)

34717 DIAGNOSTIC STUDIES IN A HALL ACCELERATOR AT LOW EXHAUST PRESSURE. Brockman, P.; Hess, R.; Bowen, F.; Jarrett, O. (NASA Langley Research Center, Hampton, Va.). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1209-14(July 1966).

Thrust measurements indicated that the coaxial Hall current accelerator can produce directed ion energies higher than the energy of an ion falling through the arc voltage. Measurements of thrust were made at tank pressures from 10^{-1} to 10^{-4} torr and at mass flows of 0.03 to zero grams per second of argon. It was found that at high tank pressure and low mass flow the measurements are affected by gas entrainment. At extremely low mass flow electrode material is eroded into the discharge. For some conditions where slight excess energies are measured the thrust measurements may give accurate velocities. Langmuir probe measurements also indicated that there may be a slight excess energy for some operating conditions. Hall current, floating potential, and Langmuir probe velocity measurements indicate that acceleration occurs close to the electrodes. (auth)

34718 INVESTIGATION OF CURRENT-SHEET MICROSTRUCTURE. Lovberg, R. H. (General Dynamics, General Atomic Div., San Diego, Calif.). AIAA (Amer. Inst. Aeron. Astronaut.) J., 4: 1215-22(July 1966).

The magnetic field and the driven gas in a plasma accelerator are separated by a thin, dense current layer, provided that the time scale of the operating impulse is sufficiently short. Theoretical models of current-sheet structure usually involve the assumption that the propellant is a fully ionized plasma; whereas in most real devices, there is no significant preionization. Thus, such formulations are of limited usefulness. Almost invariably, the current sheet itself is the ionizing agent. A series of experiments were conducted in which the object is the determination of such current sheet structure through detailed mapping of the electromagnetic field structure [E (r,t), B (r,t)] of the system, and mapping of the electron density through a modified form of schlieren photography. Discharge geometries characterized by good optical accessibility and uniform current layers have been used, i.e., a parallel-plate accelerator and an inductive theta pinch. The experimental approach is to relate E, B, and n_e through the generalized Ohm's law and thus to draw inferences concerning gross plasma drifts, ion-electron current partitioning, electrical conductivity, and electron temperature. One significant finding is that in a plasma gun running on hydrogen, an important fraction of the total current seems to be carried by ions in a displacement current occurring with the ionization process. (auth)

34719 FINITE LARMOR RADIUS HYDROMAGNETICS. Kennel, Charles F.; Greene, John M. (Princeton Univ., N. J.). Ann. Phys., (N. Y.), 38: 63-94(June 15, 1966). (MATT-363).

A complete set of fluid equations in the so-called finite Larmor radius or drift approximation is obtained by a systematic asymptotic expansion using the gyration period and radius, respectively, as small space and time parameters. The time and space scales must be linked together by velocities characterizing the plasma. In this case, these velocities are chosen to be the so-called gradient and pressure drifts, whereas in ordinary hydromagnetics the Alfvén and thermal velocities are used. This limit is particularly relevant for high temperature spatially inhomogeneous plasmas. Given this linkage, rough physical arguments are used to obtain scalings for all the other variables in the theory. Careful attention is then paid to consistency and inclusiveness in the derivation of the equations. This set is applied to the simple problem of linear wave propagation and stability in a one-dimensional inhomogeneous plasma. It provides a unified treatment of FLR wave phenomena. (auth)

34720 PARAMETRIC PLASMON-PHOTON INTERACTION. I. THRESHOLD FOR AMPLIFICATION OF PLASMONS. Goldman, Martin V. (Hughes Research Labs., Malibu, Calif.). Ann. Phys. (N. Y.), 38: 95-116 (June 15, 1966).

A nonlinear mechanism for feeding external radiation energy parametrically into a pair of collective longitudinal modes in a two-component plasma is discussed. The radiation intensity threshold for amplification of the modes is calculated when one mode is near the electron plasma frequency and the other is an acoustic-like mode with frequency proportional to the ion thermal velocity. Both frequencies are above all interparticle collision frequencies, and their sum equals the radiation frequency. The threshold appears favorable for an experiment at microwave frequencies. The process is described in terms of Maxwell equations for nonlinear fields, polarizations, and susceptibilities. The appropriate nonlinear susceptibilities are calculated from the average induced charge density, which is obtained from the 1-electron periodic Green's function. (The susceptibilities are conveniently represented by Feynman diagrams.) An appropriate nonlinear dielectric constant is then extracted using Maxwell's equations. The method is quite general, and applies to a wide variety of classical and quantum plasmas. (auth)

34721 PARAMETRIC PLASMON-PHOTON INTERACTIONS. II. ANALYSIS OF PLASMON PROPAGATOR AND CORRELATION FUNCTIONS. Goldman, Martin V. (Hughes Research Labs., Malibu, Calif.). Ann. Phys. N. Y.), 38: 117-69(June 15, 1966).

The parametric coupling of external radiation to a pair of collective longitudinal modes in a two-component plasma is treated by examining the periodic Green's function for a nonlinear Poisson's equation. One is led to formally analogous equations for the plasmon propagator (physical Green's function for the longitudinal field in the irradiated plasma) and for the correlation functions for fluctuations in the longitudinal field. The plasmon propagator, which, in principle, yields the field produced by an arbitrary external charge distribution, is appropriately Fourier analyzed in its two variables. The poles determine the threshold for parametric amplification, the frequency shifts of the new (coupled) longitudinal modes, and the gain slightly above threshold. Lowest order effects of interparticle collisions are included. The radiation may be coupled to various longitudinal mode pairs. Two cases are considered: A high-low frequency pair consisting of an electron plasma mode and an ion-acoustic-like mode, and a high-high frequency pair consisting of two electron plasma modes. The threshold for the former effect is two orders of magnitude lower than for the latter. The effects of unequal electron and ion temperatures are examined. When the ions are colder than the electrons, significant lowering of the threshold results. Below threshold, the equations for the steady state correlation functions are solved, and fluctuation-dissipation, or Nyquist theorems, are derived for the nonequilibrium plasma. The steady state noise energy per plasma mode is calculated, and a large enhancement over equilibrium is found. (auth)

34722 LOWERING OF IONIZATION POTENTIALS IN PLASMAS. Stewart, John C.; Pyatt, Kedar D. Jr. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Astrophys. J., 144: 1203-11(June 1966).

The average electrostatic potential near a nucleus immersed in a plasma is evaluated using a finite-temperature Thomas-Fermi model. The part of this potential directly attributable to the presence of the plasma is isolated and is used to evaluate the reduction in ionization potential for a wide range of parameters. A simple analytic solution, exhibiting Debye-Hückel and ion-sphere limits, is also obtained and is used as an interpolatory device. (auth)

34723 EFFECT OF THE HELICAL MAGNETIC FIELD ON PLASMA OHMIC HEATING IN S-1 MACHINE. Blinov, P. I.; Gavrilov, B. I.; Cheremnykh, P. A.; Yashin, N. M. At. Energ. (USSR), 20: 310-15(Apr. 1966). (In Russian).

Some experimental data on the effects of a helical triple-input magnetic field on the development of the charge conductivity and on the stabilization of the plasma pinch are presented. It was found that the helical field improves the development of the plasma charge and heating. The superposition of helical fields does not affect the confinement time. (G.O.Y.)

34724 ACCELERATION OF CHARGED PARTICLES IN A FIELD OF PLANE WAVES WITH CHANGING PHASE VELOCITIES. Krasovitskii, V. B. At. Energ. (USSR), 20: 347-8(Apr. 1966). (In Russian).

The acceleration of free charged particles by means of a transverse field with an alternating phase velocity was studied. It was proposed that an autophasing takes place between the synchronized particle and wave and that a focus exists along the transverse velocities of the accelerating particles. (G.O.Y.)

34725 MEASUREMENT OF THE ELECTRON TEMPERATURE IN A PLASMA BEGINNING WITH THE RATIO OF INTENSITY OF TWO RAYS. Schwob, Jean-Louis (EURATOM-CEA, Fontenay-aux-Roses, France). Compt. Rend., Ser. B, 262: 1264-7(May 9, 1966). (In French).

The electron temperature T_e in a pulsed discharge was measured by comparing the intensities of two rays of C IV, N V, and O VI. The possibility of using the visible rays 3s – 3p was noted. The theoretical intensity ratios were given as a function of T_e obtained from excitation cross sections calculated recently by Bely. The results are compared with those deduced from previously considered approximation formulas. (tr-auth)

34726 SPECTROSCOPIC STUDY OF A HELIUM PLASMA CREATED BY A LASER BEAM. Durand, Yves;

Veyrie, Pierre (CEA, Villeneuve-St.-Georges, France). Compt. Rend., Ser. B, 262: 1283-6(May 9, 1966). (In French).

When a laser beam is focused in a gas, a plasma ball is formed. The light emission resulting makes it possible to obtain the ray profile at different times. From these profiles an approximate determination can be made of the temperature and of the electron density. The results are compatible with the hydrodynamic model. (tr-auth)

34727 DISTRIBUTION OF THE ELECTRON TEMPERATURE AT THE INTERIOR OF AN ARGON PLASMA PRODUCED BY AN h-f GENERATOR. Molinet, Frederic (Societe d'Etudes Chimiques pour l'Industrie et l'Agriculture, Argenteuil, Val-d'Oise, France). Compt. Rend., Ser. B, 262: 1377-80(May 23, 1966). (In French).

The electron temperature was determined as a function of the distance to the axis of the inducing windings from measurements of the absolute intensity of the λ 7503.87 Å 1 of the argon atom. These results are then compared with those obtained by the ratio of the intensities of the λ 7503.87 Å 1 and λ 8521.44 Å 1 rays. (tr-auth)

34728 WAVE COUPLINGS AND GENERATION OF HARMONICS IN A DOUBLE-BEAM SYSTEM. Etievant, Claude; Olivain, Jack; Perulli, Mariano (EURATOM-C.E.A., Fontenay-aux-Roses, France). Compt. Rend., Ser. B, 262: 1425-8(June 1, 1966). (In French).

A series of experiments are described that show that the harmonics of the gyromagnetic semifrequency in a symmetric system of two electron beams seem to be produced by nonlinear effects. The generation of the complex spectra was detected by making the waves developing spontaneously in the medium interact with waves excited from the exterior with a generator. (tr-auth)

34729 EFFECT OF ION MOTION ON THE REFLECTION OF AN ELECTROMAGNETIC WAVE FROM PLASMA. Petrzilka, V. A. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 16: 551-4(1966).

An electromagnetic wave with electric vector parallel to the plasma boundary falls from a vacuum on a half-space filled with magnetoactive plasma and bounded by a particle-reflecting wall. A comparison is made of the effect of thermal motion of electrons and ions on the boundary, on the coefficient of reflection and on the absorbed energy. (auth)

34730 HARMONIC GENERATING IN A MILLIMETER-WAVE GAS DISCHARGE PLASMA. Tamaru, Takeshi; Chiyoda, Katsuji. Denki Shikensho Iho, 30: 241-51(Mar. 1966). (In Japanese).

An experimental investigation was performed on short millimeter-wave generation by a millimeter-wave gas discharge frequency multiplier. The minimum conversion losses obtained in air are 25 db for the 2nd harmonic and 35 db for the 3rd harmonic, which are comparable with those obtained in centimeter wavelength regions. Relations between the harmonic powers and the pressure, and effects of the geometrical configurations and the gap lengths of electrodes on the harmonic powers are also investigated. (auth)

34731 STABILIZATION OF DRIFT INSTABILITY IN TRAPS WITH A MAGNETIC FIELD WHICH INCREASES TOWARD THE BOUNDARY. Ivanov, A. A. Dokl. Akad. Nauk SSSR, 166: 1084-7(Feb. 11, 1966). (In Russian).

Drift instability in a plasma trap is considered. While it would be natural to assume that a magnetic field which increases toward the boundary of the plasma should stabilize drift instability since it is not advantageous from an energy standpoint for the particles to pass into the region of intense magnetic fields, it is shown that this type of stabilization does not in fact take place. The case where the electron temperature is much higher than the ion temperature is considered and the simplest geometry is assumed: a rare plasma in the field of an infinitely long straight filament, where the external boundary of the plasma is a dielectric cylinder. Oscillations are considered for which the phase velocity along the magnetic field is much less than the Alfvên velocity and the speed of ionic sound. The motion of ions along the field is disregarded. It is found that stability of drift waves is associated only with a special form of the distribution function. The plasma is stable with respect to build-up of oscillations in the drift waves for any gradients in the magnetic field. (ATD)

34732 FLOW PAST A BODY WITH STRONGLY RAREFIED PLASMA. Pashchenko, N. T. pp 601-8 of Fluid Dynamics Transactions. Vol. 2. New York, Pergamon Press, 1965.

The problem of steady flow of strongly rarefied plasma past a charged body is solved. Assuming that the charge of the body and the Debye radius are small compared with a characteristic dimension of the body, the field of the potential and the forces acting on the body are derived. (J.F.P.)

34733 TWO-DIMENSIONAL STATIONARY FLOW OF HIGH-CONDUCTANCE PLASMA IN A COAXIAL SYSTEM. Brushlinskii, K. V.; Gerlakh, N. I.; Morozov, A. I. Izv. Akad. Nauk SSSR, Mekh. Zhidkosti Gaza, No. 2, 189-92 (Mar.-Apr. 1966). (In Russian).

On assuming that the system is axially symmetric, that the plasma flow is isentropic, that the density and pressure at the channel inlet are constant, that the plasma is nonviscous with no joule heating, and that the magnetic Reynolds number $R_m \gg 1$, it is shown that the establishment of flow in a two-dimensional, coaxial channel takes place within a time $t = L/v_{max}$, where L is the length of the system, and v_{max} is the plasma velocity at the exit. No large-scale oscillations of the system are noted. Thus, acceleration of the plasma takes place in a stable manner. The plasma velocity at the exit depends on the radius r. The plasma density does not always decrease regularly along the z axis. Electric eddy currents can be observed on parts of the electrodes in a number of variants. (TTT)

34734 INSTABILITY OF THREE- OR FOUR-COMPONENT (ELECTRON, ION AND BEAM) PLASMA SYSTEMS. Ohnuma, Toshiro; Hatta, Yoshisuke (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 21: 986-95(May 1966).

The instability of a beam-plasma system with no magnetic field is investigated mainly by means of the graphical analysis of the dispersion equation. Unstable regions are determined in detail in kinetic theory approach for three types of waves of electron beam-electron coupling, ion beam-electron (electron beam-ion) coupling and ion beam-ion coupling. The effect of the stationary electron appears in the region of the beam-ion coupling in a three-component plasma and in the region of all the waves except electron beam-electron coupling in a four-component plasma. (auth)

34735 HYDRODYNAMIC FLUCTUATIONS AND CORRELATIONS OF A PLASMA IN A MAGNETIC FIELD. Ichimaru, Setsuo (Tokyo Univ.). J. Phys. Soc. Jap., 21: 996-1003(May 1966).

The frequency- and wave-vector-dependent dielectric tensor of a drifted plasma in a magnetic field is calculated in the framework of the macroscopic diffusion equations. The dynamic form factor is then evaluated, which may give an adequate description of correlations in large distances and long time separations. The diffusion mode, which characterizes the hydrodynamic excitations and correlations of the plasma, is investigated. Another mode of density fluctuation excitations arising from Cherenkov emission of the ion cyclotron waves is also studied together with the associated instabilities. (auth)

34736 THE DETERMINATION OF THE PLASMA TEMPERATURE WITH THE AID OF STARK BROADENING OF SPECTRUM LINES WITH AN APPLICATION TO TRANSIENT DISCHARGES. Bardocz, A.; Voeroes, T. (Univ. for Technical Sciences, Budapest). J. Quant. Spectros. Radiative Transfer, 6: 351-6(May-June 1966).

Using the Stark-effect broadening of spectrum lines, $\Delta\gamma$ and the expression $\Delta\gamma = aT^{-\frac{1}{2}}[\exp - (b/T)]\, g(T)$, the temperature T in a plasma may be determined. Here a and b are known constants and g(T) is a known temperature-dependent function. With the aid of time-resolved

spectroscopic techniques, the wavelength broadening was determined as a function of time in a spark discharge and, using the preceding formula, the temperature was estimated as a function of time in the discharge. For the measurements, the time-resolved spark spectra of Zn, Cd, Mg, and Hg were used. (auth)

34737 SPECTROSCOPIC STUDY OF LOW DENSITY CESIUM AND CESIUM–HELIUM DISCHARGES. Curry, Ronald H. (Sperry Rand Research Center, Sudbury, Mass.). J. Quant. Spectros. Radiative Transfer, 6: 357-67 (May-June 1966).

Excitation temperatures and Saha temperatures are determined for an r-f excited cesium discharge in the electron density range from $2.5 \times 10^9 - 3 \times 10^{11}/cm^3$. The consequence of self-absorption of both resonance and nonresonance states in measuring temperatures is discussed. It is shown that cesium ion excitation is inversely related to ion density and that this excitation cannot be described by a "temperature." Addition of helium over the pressure range 0.1–10 torr has no effect on ionization or cesium excitation other than to allow observation of Cs spectra at a lower pressure than is possible in pure cesium. A discussion of the utility of these observations in describing the nonequilibrium state of the discharge is included. (auth)

34738 ON THE ELECTRICAL CONDUCTIVITY OF A WEAKLY IONIZED TURBULENT PLASMA. I. Nishikawa, Kyoji (Kyoto Univ.). Kakuyugo Kenkyu, 16: 348-59 (Apr. 1966). (In Japanese).

On the basis of magnetohydrodynamic equations, the effect of density fluctuations on the frequency dependent electric conductivity of a weakly ionized isothermal plasma is investigated. Only the case in which the magnetic field is static and homogeneous and in which the external electric field is parallel to the magnetic field is considered. The density fluctuations or waves are assumed to be formed by a certain driving force which acts either only on the electrons or only on the ions. The approximations involved are (1) the neglect of the inertia term, (2) the neglect of the mode-mode coupling term except when it acts as a driving force and, (3) the neglect of the response of the driving force to the external electric field. Some special cases are considered in detail. (auth)

34739 MACROSCOPIC TREATMENT OF ION SHEATHS IN MAGNETIC FIELDS. Furukane, Utaro (Shizuoka Univ., Japan); Oda, Toshiatsu. Kakuyugo-Kenkyu (Nagoya), 16: 169-88 (Mar. 1966).

Macroscopic equations without collision terms were employed to obtain a solution for an ion sheath in a plasma with macroscopic flow in a magnetic field. It has been shown that the kinetic energy of ions arriving at the sheath decreases with increased magnetic field and equals $kT_e/2$ for no field. Numerical computations were performed for the structure of a sheath in helium plasma with ambipolar diffusion. It was found that the static potential varies parabolically in the sheath, as is the case for no applied magnetic field. (auth)

34740 THEORY OF DIPOLE RESONANCES AT THE RADIAL INHOMOGENEOUS PLASMA CYLINDER. Wolschke, S. Monatsber. Deut. Akad. Wiss. Berlin, 7: 517-27 (1965). (In German).

The scattering of a plane electromagnetic wave at a radial inhomogeneous plasma cylinder was considered. The electric vector and the wave vector of the incident wave are perpendicular to the cylinder axis and their wave length is so large with respect to the cylinder radius that the dipole scattering overpowers the higher multipole scattering. The results are shown graphically. (J.S.R.)

34741 RELATIVISTIC PLASMA IN A MAGNETIC FIELD. Kursunoglu, B. (Univ. of Miami, Coral Gables, Fla.). Contracts AT(40-1)-2761; AF 49(638)-1260. Nuovo Cimento (10), 43B: 209-26 (June 11, 1966).

Transverse and longitudinal oscillations of a low-density relativistic plasma in the presence of a constant magnetic field are considered by neglecting the collisions. The most general form of the relativistic dispersion relations for linear plasma oscillations is derived and the two extreme cases of zero and infinite equilibrium temperatures are discussed. (auth)

34742 SMALL-AMPLITUDE WAVES AND SCREENING IN DENSE DEGENERATE PLASMA. Goldstein, J. S. (Brandeis Univ., Waltham, Mass.). Contract AF 19(628)-4019. Nuovo Cimento (10), 43B: 282-300 (June 11, 1966).

The propagation of electro-acoustic waves in a dense degenerate plasma is considered, for the density range (10^6-10^9) g/cm^3 and at temperatures up to (10^8-10^9)°K. Appropriate dispersion relations are obtained, for longitudinal and transverse waves, including the effects of ionic mobility. It is found that although the ion gas plays only a small role in wave propagation, its role in screening cannot be neglected. (auth)

34743 EXPERIMENTAL STUDY OF A RADIO-FREQUENCY PLASMA IN A STEADY MAGNETIC FIELD. Agnello, V.; Barassi, N.; Caldirola, P.; Finzi, U.; Fontanesi, M.; Sindoni, E. (Univ., Milan. Consiglio Nazionale delle Ricerche, Rome). Nuovo Cimento (10), 43B: 361-74 (June 11, 1966).

The results of a series of experimental observations performed on a plasma excited by a radiowave in the presence of a steady magnetic field are discussed. The values of electron temperature, electron density, and collision frequency, measured by means of particular diagnostic methods are reported. The power absorbed by the plasma is shown to have a maximum for a value of the gyromagnetic frequency ω_H lower than the frequency ω of the radiowave. This phenomenon is explained by an average electron theory, taking into account a restoring force arising from collective interactions. (auth)

34744 TEMPERATURE DEPENDENCE OF THE ELECTRON-ION RECOMBINATION COEFFICIENT IN NEON AFTERGLOW PLASMAS. Nygaard, K. J. (Sperry Rand Research Center, Sudbury, Mass.). Contract AF19(628)-4183. Phys. Lett., 22: 56-8 (July 15, 1966).

By means of microwave heating of the electrons in a neon afterglow followed by measurements of light intensity and electron temperature T_e, it was found that the recombination coefficient is proportional to $T_e - 1.4 \pm 0.2$. (auth)

34745 EXPERIMENTAL EVIDENCE OF "OBLIQUE" SHOCK WAVE PROPAGATION IN A THETA-PINCH DISCHARGE. Martone, M. (EURATOM-CNEN, Rome). Phys. Lett., 22: 73-4 (July 15, 1966).

Magnetic probe measurements on an amplifying oscillatory shock transition are reported. Measurements are in agreement with the theory of "oblique" shock waves. (auth)

34746 OBJECTIVES AND FOCAL POINTS IN THE WORK OF THE SIEMENS-SCHUCKERT RESEARCH LABORATORY. Welker, Heinrich. Siemens Rev., 33: 91-7 (Mar. 1966).

Research programs being conducted at the laboratory are outlined, and specific project results are reported. Plasma physics is being studied, and the main interest in the field of gas discharges is focused on the physical processes taking place in stationary and nonstationary arc discharges. The research conducted is concentrated on the phenomena responsible for the decay in the electric conductivity following interruption of the arc current. The relation between the thermal conductivity or cooling of the plasma and the decrease in the electric conductivity is being examined. Since the composition of the arc plasma has a decisive influence on its thermal conductivity, the behavior of arcs in various gas atmospheres is also being studied. In the field of magnetohydrodynamics, the phenomena taking place in a z-θ pinch discharge were studied and suitable diagnostic methods developed for this purpose. A special arrangement was devised which makes it possible to avoid the disturbing macroscopic instabilities experienced previously. Plasmoids (high-temperature plasma clouds) were accelerated up to a velocity of 1.8×10^8 cm/sec by an electrodeless arrangement. This is appreciably higher than the exhaust velocities of chemical power units (3×10^5 cm/sec) and can probably be increased even

further. The research laboratory radiochemical investigations have shown that radiochemical methods can be successfully applied in a large number of research fields in solid-state physics, as well as for preparative and analytical work. (BBB)

34747 COSMIC RAYS: NEW RESULTS AND PERSPECTIVES IN RESEARCH. Zhdanov, G. B. Vestn. Akad. Nauk SSSR, No. 4, 130-7(Apr. 1966). (In Russian).

Cosmic-ray investigations are carried out in two ways: by study of the nuclear physical interactions of elementary particles and of the distribution of particles of very high energies in the universe. Investigation methods include atmospheric shower observations and recording the fluorescence of molecular nitrogen in the optical spectral range (0.3 – 0.4 $\mu\mu$) caused by excitation of air atoms by high-energy particles. Experimental investigations of nuclear interactions use piles of photographic emulsion plates raised to the stratosphere by aerostats. An instrument was developed for measuring the nuclear interaction of particles. This instrument, called an ionization calorimeter, measures the total energy of the components of nuclear interaction using thick strata of heavy matter. When μ-mesons were separated from high-energy neutrinos, experiments were performed to study the μ-meson and neutrino components of secondary cosmic rays. The first hypothesis on the nature of cosmic rays was the photon hypothesis, which replaced the electron hypothesis after the latitudinal effect of cosmic rays in the geomagnetic field was detected. Investigations of photon and electron-positron components are being made. In the quiet sun period (1963–1965), sunspots, chromospheric flares, and magnetic storms seldom appeared and study of the solar component of cosmic rays decreased. Instead of solar phenomena, the spectra of galactic cosmic rays were investigated. Results obtained showed parallel rates for sunspots and cosmic ray intensity, with slight deviations associated with the Forbush effect. The relation of the two phenomena was attributed to the solar wind. This coincidence is considered to be associated with magnetic fields, plasma flows, solar activity, and physical phenoma in the universe. (ATD)

34748 CONTINUOUS EMISSION AND ABSORPTION OF PLASMAS. Peters, Theo (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart). Z. Flugwiss., 14: 89-98(Feb. 1966). (In German).

The theory of continuous emission and absorption of plasmas is presented, using the exactly calculable radiation of a H plasma. The conditions of pressure and temperature under which plasmas of given dimensions radiate as a black body are derived. Continuous radiation integrated over all frequencies for H at atmospheric pressure, and continuous radiation as a function of frequency at 1×10^4 and 1.74×10^{4o}K, are illustrated. The frequency dependence of the temperature at which maximum continuous radiation occurs is discussed. A parabolic radial temperature distribution is assumed, and the radiation distribution contributing to this from the Balmer and Lyman continua is worked out. A pressure-temperature plot illustrates the region in which a Z-fold ionized plasma becomes optically dense and radiates like a black body. Another illustrates the pressure-temperature region for which Cs, Hg, H, and He singly charged ion plasmas radiate like black bodies. (BBB)

34749 SECTOR DISK APPARATUS FOR SPECTROSCOPIC OBSERVATIONS OF DECAYING PLASMAS. Broemer, H. H.; Hesse, J. (Technische Hochschule, Brunswick). Z. Instrum., 74: 126-9(Apr. 1966). (In German).

Recording of the transmission spectrum of a N_2 plasma is considered, with a discussion of problems in technique and instrumentation. In the use of a rotating slit-disk device, large rotation frequencies must be used to provide optimal time resolution for spectrographic observations. Therefore, the repetition frequency of the exposure period is also large. Design and construction of a periodically working mechanical time-shutter designed for spectroscopic observations of decaying plasmas is described. The time resolution is 0.1 msec. By combining two concentric rotating disks with slits and an additional magnetically driven shutter the repetition frequency can be reduced to 0.2 kc. The switch-off pulses for the discharge are generated by a magnet fixed on one of the rotating disks and a Hall-generator. Examples are shown of spectra obtained with the device on a N_2 plasma. (BBB)

34750 SURFACE WAVES IN THE ELECTRON PLASMA. Wagner, D. (Univ., Cologne). Z. Naturforsch., 21a: 634-42(May 1966). (In German).

The linearized Boltzmann–Vlasov-equation is solved for a semi-infinite degenerate plasma and a plasma within a layer. It is shown, that the surface oscillations first discussed by Ritchie have a linear dependence on the wave vector and are damped. (auth)

34751 DOUBLE-BEAM INSTABILITY IN A SYSTEM OF INTERPENETRATING ION BEAMS. Gabovich, M. D.; Kirichenko, G. S. (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Zh. Eksp. Teor. Fiz., 50: 1183-6(May 1966). (In Russian).

It is shown that double beam ion instability appears in a system of two ion beams moving in a given direction with different velocities providing the energy difference of the beams does not exceed the threshold value. The appearance of this instability results in effective energy exchange between the beams which sharply rises with increase of the ion beam current. (auth)

34752 LOCALIZATION OF A LINEAR HIGH-FREQUENCY DISCHARGE. Bobyrev, N. A. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 36: 417-26(Mar. 1966). (In Russian).

The possibility of employing diaphragms and a longitudinal magnetic field for the lateral confinement of high frequency discharges in helium, hydrogen, air, argon, and krypton at pressures from 10^{-4} to 10^{-2} mm Hg was investigated. Such confinement, if successful, would provide an experimental technique for investigating the dynamic stabilization with the aid of h-f fields of a current carrying plasma filament. The radial distributions in the region between the constrictions of the ionization and the azimuthal component of the magnetic field (due to the current in the plasma) were measured during the discharge by means of movable probes. It was found that when the longitudinal magnetic field exceeded a certain critical intensity, which increased with increasing excitation frequency, both the ionization and the current were almost entirely confined to the 3.5 cm diameter region defined by the constrictions for the full duration of the discharge, except when there was resonance between the ion Larmor frequency and the frequency of the exciting oscillator. In the latter case both the ionization and the current rapidly filled the full 7.2-cm diameter of the discharge tube. Experiments were also made with direct current discharges. These were initiated by a 75 μsec h-f discharge and were maintained for some 400 μsec, the strength of the direct current in the plasma being about 2 kamp. These discharges were also confined to the region defined by the constrictions when the longitudinal magnetic field was sufficiently strong. A magnetic field of 450 Oe was adequate to confine a d-c discharge in argon at 3.5×10^{-4} mm Hg. It is concluded that a linear high frequency discharge can be laterally confined by means of diaphragms and a longitudinal magnetic field. The possibility of such confinement is ascribed to the low transverse conductivity of the plasma in the magnetic field. The failure of the plasma to remain confined under cyclotron resonance conditions is ascribed to the anomalous diffusion previously noted under these conditions. (ATD)

34753 DYNAMIC STABILIZATION OF A CURRENT-CARRYING PLASMA CYLINDER. Bobyrev, N. A. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 36: 427-37(Mar. 1966). (In Russian).

The apparatus and experimental techniques previously described were employed to investigate the effect of the presence of h-f fields on the magnetohydrodynamic instabilities of a current carrying plasma filament. In the experiments the h-f field was provided by the current in the

plasma filament, which was produced by h-f excitation of gas at pressures of the order of 10^{-3} mm Hg. At high longitudinal magnetic field intensities, when hydrodynamic instability would not be expected even in the absence of h-f fields, there were observed violent fluctuations of the magnetic field due to the current in the plasma filament. The fluctuations at different distances from the axis were not correlated, and these fluctuations were therefore not due to hydrodynamic instability. The frequencies of these fluctuations were in the range to be expected for drift oscillations of a nonuniform plasma, and the fluctuations are tentatively ascribed to drift oscillations although it was not possible to suppress them with the aid of a multipole magnetic field produced by six conductors parallel to the axis of the discharge tube. In weak longitudinal magnetic fields there were observed regular fluctuations in the azimuthal component of the field, the frequency of which decreased linearly with increasing longitudinal magnetic field strength and became equal to zero when the longitudinal magnetic field rose to four times the azimuthal field at the boundary of the plasma filament. These fluctuations were correlated, and they are ascribed to hydrodynamic oscillations of the plasma filament. Experiments were also performed with d-c plasma filaments. Magnetohydrodynamic oscillations of the plasma filament were observed in this case also, and they were stabilized when the ratio of the longitudinal magnetic field to the azimuthal field at the boundary of the filament was 13 or greater. It is concluded that the presence of an h-f field aids considerably in the stabilization of magnetohydrodynamic oscillations of a current carrying plasma filament. The longitudinal magnetic field strengths required for stabilization were considerably higher than predicted by current theories, both in the case of the high frequency plasma currents and in the direct current case. This discrepancy is ascribed to inadequacy of the theory. (ATD)

34754 COHERENT REACTION OF A TRANSPARENT CLUSTER OF CHARGES UNDER THE INFLUENCE OF RADIATION. Yankov, V. V. Zh. Tekh. Fiz., 36: 438-42(Mar. 1966). (In Russian).

The interaction of a cluster of charged particles with an electromagnetic wave is discussed. It is assumed that the cluster is small compared with the wavelength of the incident waves, that it is nearly transparent, and that it is quasineutral, i.e., that the Coulomb repulsions of the particles are neutralized by the presence of particles of opposite charge whose motions need not be considered. The problem is treated by a perturbation technique: the current induced in the cluster by the unmodified incident wave, the radiation field due to these currents, and the forces on the particles in different parts of the cluster due to the perturbed field are calculated. Two cases are discussed in detail: a longitudinal wave incident on a spherically symmetric cluster, and a "vortical" wave (a wave in which the electric vector is in the azimuthal direction) incident on a toroidal cluster. It is shown that the longitudinal wave not only accelerates the spherical cluster but exerts a focusing action in the direction of propagation and that the vortical wave stabilizes the toroidal form of the toroidal cluster. The stabilizing action of the vortical wave on the toroidal cluster is not affected by the presence of a longitudinal magnetic field, which can therefore be employed to stabilize the large radius of the torus. The calculations are valid only in the absence of such general types of plasma instabilities as, for example, parametric resonance or nonlinear conversion of waves. (ATD)

34755 HIGH-FREQUENCY HEATING OF A DENSE PLASMA IN A METALLIC CHAMBER. Shvets, O. M.; Tarasenko, V. F.; Ovchinnikov, S. S.; Brzhechko, L. V.; Pavlichenko, O. S.; Tolok, V. T. Zh. Tekh. Fiz., 36: 443-6(Mar. 1966). (In Russian).

Hydrogen-helium and hydrogen-argon plasmas at pressures in the $(1-3) \times 10^{-3}$ mm Hg range with charged particle densities of the order of 10^{14} cm^{-3} were produced in the "Vikhr" magnetic mirror machine and were heated by ion cyclotron waves which were produced in the vicinity of the magnetic mirror and propagated to the center of the discharge chamber where the magnetic field was weaker and corresponded to the proton cyclotron resonance. The 150 kw oscillator operated at a frequency of 1.82 MHz. Regular oscillations at frequencies of the order of 20 kHz of the intensities of spectrum lines were observed at magnetic field strengths close to the proton cyclotron resonance. These oscillations appeared when waves were being excited in the plasma and were due to eccentric rotation of the plasma filament as a whole with respect to the axis of the chamber, as was confirmed by longitudinal observation with two photomultipliers mounted 3 cm from the axis. The ion temperatures were determined from the Doppler broadening of spectrum lines. The temperature of the additional gas (helium or argon) increased sharply as the strength of the magnetic field approached the proton cyclotron resonance value. Argon temperatures as high as 250 ev were observed. Temperatures of various impurity ions were also measured; these temperatures were independent of the mass of the impurity ion. The width of H_β interpreted as Doppler broadening, indicated a much lower temperature for hydrogen atoms than for the various ions. This is ascribed to the short life of a hydrogen atom in the plasma. The temperature of the plasma decreased rapidly with increasing distance from the axis, being down by a factor of 5 at 4 cm from the axis. The ion temperature increased rapidly with increasing high-frequency power, and much higher temperatures could apparently be achieved by increasing the h-f power and the magnetic field strength. It is concluded that a dense plasma containing two kinds of ions can be heated by resonance production of ion cyclotron waves in ions of one kind, but that the mechanism of energy transfer between the two different kinds of ions is not understood. (ATD)

34756 EXPERIMENTAL INVESTIGATION OF PLASMA RESONANCES IN AN IONIZED ARGON JET. Kiritsyn, Yu. I. Zh. Tekh. Fiz., 36: 447-52(Mar. 1966). (In Russian).

The scattering of 8.97 and 36.6 kMHz microwaves was measured by jets of argon plasma. The plasmas were produced in 15–20 v, 100–500 amp arcs between a molybdenum anode and a tungsten cathode in argon at 130 to 600 mm Hg and were drawn through a 5-mm diameter supersonic nozzle and a 20-mm diameter alundum tube into a $40 \times 40 \times 40$ cm^3 evacuated chamber. The rate of argon consumption G was varied from 0.09 to 0.51 g/sec and the power N_0 in the arc was varied from 2 to 10 kw. The microwaves were produced by a klystron oscillator, were radiated and received by conventional horns, and were recorded with a superheterodyne receiver. The horns faced each other at a distance of 50 cm, and the plasma jet was midway between them. The scattering was determined from the difference between the received powers in the presence and absence of the plasma. The apparatus was calibrated by measuring the scattering from various dielectric and metallic cylinders. The plasma jet was some 3 cm in diameter and 50-cm long; these dimensions may be compared with the 3.35- and 0.82-cm wavelengths of the microwaves. Curves are presented showing the scattering coefficient at each frequency as a function of G for fixed N_0 and as a function of N_0 for fixed G. Both curves for the higher frequency show two peaks, and those for the lower frequency show three peaks. These peaks are interpreted in terms of theories according to which they are associated with excitation of radial plasma waves and longitudinal electrostatic oscillations near the boundary of the plasma. It is suggested that measurements of the type discussed here might be used to investigate the lateral distribution of electrons in plasma jets. (ATD)

34757 ASYMMETRIC WAVES IN PLASMA WAVEGUIDES. Brodskii, Yu. Ya.; Vagin, V. A.; Kotov, V. I. Zh. Tekh. Fiz., 36: 453-9(Mar. 1966). (In Russian).

By asymmetric waves, waves that do not possess full axial symmetry are understood. The electric and magnetic fields of the waves discussed have the form $F(r) \exp [i(ft - kz + n\theta)]$ in cylindrical coordinates r, θ, z, where f is the frequency, k is a propagation constant, and n is an integer not less than 1. The propagation of these waves is

discussed in three types of plasma waveguide: (1) the region r < a is empty and the region r > a is filled with an isotropic plasma with dielectric constant $(f^2 - f_0^2)/f^2$, where f_0 is the plasma frequency; (2) the region r < a is empty, the region a < r < b is filled with the isotropic plasma of case (1), and the surface r = b is conductive; and (3) the region r < a is filled with a plasma that is highly magnetized by an axial magnetic field, the region a < r < b is empty or filled with an isotropic nondispersive medium, and the surface r = b is conductive. Case 1 is treated in most detail. The dispersion equation is derived and its roots are discussed separately for slow waves, waves with phase velocity c (the velocity of light in vacuum), and fast waves. Asymmetric waves with phase velocity c always have a positive group velocity; in this respect their behavior differs from that of symmetric waves. In the limit of very high phase velocity the dispersion equation factors into two equations representing two groups of hybrid waves. Cutoff conditions and dispersion curves for waves of these groups are presented graphically. The propagation of asymmetric waves in plasma waveguides of types 2 and 3 is discussed in much less detail; the essential equations are given and some limiting forms are pointed out. (ATD)

34758 STATIONARY FIELDS AND CURRENTS INDUCED IN PLASMA BY STRONG HIGH-FREQUENCY FIELDS. Kotsarenko, N. Ya.; Fedorchenko, A. M. (Kiev State Univ.). Zh. Tekh. Fiz., 36: 460-5(Mar. 1966). (In Russian).

In a "quasilinear approximation" the stationary charge and current distribution induced in a plasma by a high frequency field is discussed. The nonlinear effect involved in the calculation is the average force on the electrons proportional to the gradient of the square of the h-f electric field. Objection is made to the assertion that the plasma can be treated as neutral in the zeroth approximation. The calculations are based on the magnetohydrodynamic equations for the motion of the electrons of a cold plasma. The effect of collisions of the electrons with the surrounding particles is taken into account by a term in the equation of motion representing a retarding force proportional to the velocity. These equations are approximately solved by a perturbation procedure dependent on the smallness of the parameter eE/mf^2L, where e and m are the electron charge and mass, E is the applied high frequency electric field, f is its frequency, and L is a length characterizing the inhomogeneity of the field. The h-f motions of the electrons are eliminated from the solution by averaging over time, and equations are derived from which the steady state charge and current distribution induced in the plasma by the action of a given h-f field can be calculated. The forms to which these equations reduce for an isotropic plasma and for a strongly magnetized plasma are given and a specific example is worked out in each case: the charge and current distributions induced in a cylinder of isotropic plasma by E waves propagating on the surface and those induced in an infinite magnetized plasma by electromagnetic waves propagating transversely to the magnetic field are calculated. (ATD)

34759 KINETIC THEORY OF EXCITATION OF LONGITUDINAL WAVES IN A BOUNDED PLASMA. Kurilko, V. I.; Popov, V. A. (Kharkov State Univ.). Zh. Tekh. Fiz., 36: 466-9(Mar. 1966). (In Russian).

The kinetic equation is employed for small deviations of the electron distribution function from the Maxwellian form to discuss excitation in a plasma with a plane boundary of longitudinal waves by an oscillating electric field perpendicular to the boundary. As the boundary condition it is assumed that the fraction p of the plasma electrons that strike the boundary are specularly reflected and the fraction 1 − p of them are diffusely reflected. From the kinetic equation and this boundary condition there is derived an integral equation for the field. For the case p = 1 this integral equation was derived and its solution discussed by L. D. Landau; the integral equation is treated for general values of p. For the case p = 0 the calculations are carried through to the end and expressions are derived for the distribution of the field near the plasma boundary. It is found that in this case there is formed a surface charge at the plasma boundary, as a result of which the field distribution for frequencies near the plasma frequency is significantly different from the distribution obtained by Landau for the case p = 1. (ATD)

34760 DETERMINATION OF ELECTRON ENERGY DISTRIBUTION FUNCTIONS IN HOLLOW CATHODE DISCHARGES IN HELIUM–NEON MIXTURES. Afanas'eva, V. L.; Lukin, A. V.; Mustafin, K. S. Zh. Tekh. Fiz., 36: 526-32(Mar. 1966). (In Russian).

Electron concentrations and energy distributions were measured and excited state populations were calculated in 100–200 mamp hollow-cathode discharges in helium-neon mixtures. The neon partial pressure was 0.1 mm Hg in all the measurements; the helium partial pressure was varied from 0.3 to 7 mm Hg. The discharges took place in a 30 cm-long 1.2 cm-diameter water-cooled kovar tube which served as cathode. The electron density and distribution measurements were made with three 6-mm long 0.06-mm diameter molybdenum probes, which could be retracted into side tubes to prevent their destruction during preliminary cleansing discharges. The distribution functions were calculated from the probe characteristics with the formula of M. Druyvestein. The second derivative of the probe characteristic required for this calculation was obtained by modulating the probe potential at 1 MHz and measuring the 2 MHz component of the probe current. The distribution curves obtained for the hollow cathode helium-neon discharges were rather close to Maxwellian. No high-energy maxima were found, although there was a pronounced bulge at about 17 ev on the distribution curve for the discharge in which the helium pressure was 0.3 mm Hg. The observed electron temperatures and concentrations ranged between 19.5×10^3 and 68.5×10^3°K and between 3.3×10^{10} and 11×10^{10} cm^{-3}. The electron temperatures and concentrations were higher near the anodes than midway between them. The measured electron densities and distribution functions were employed to calculate the populations of the metastable 2^3S_1 helium level and the 1s, $2p_4$, and $2s_2$ neon levels (Paschen's notation). Cascade and stepwise excitation processes and electron collisions of the second kind were neglected in these calculations, but collisions of the second kind between helium and neon atoms and collisions with the wall were taken into account in calculating the lifetime of the 2^3S_1 helium level. The data of V. P. Bennet (UFN, 81: 119(1963)) were employed for the lifetimes of the $2p_4$ and $2s_2$ neon levels. There was population inversion between the $2s_2$ and $2p_4$ levels. At a helium pressure of 0.3 mm Hg, electron collisions and collisions of the second kind contributed approximately equally to the population of the $2s_2$ neon level; at helium pressures above 3 mm Hg the contribution from collisions of the second kind was predominant. As a function of the helium partial pressure, the population of the $2s_2$ neon level went through a minimum at 1–2 mm Hg and a maximum at 4–6 mm Hg. (ATD)

34761 ON THE LOW-VOLTAGE CESIUM VAPOR ARC. Dunaev, Yu. A.; Yavor, I. P.; Busygin, E. P. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 36: 533-41(Mar. 1966). (In Russian).

The visible and near-infrared spectra of low-voltage hot-cathode cesium vapor arcs were investigated. The investigation was undertaken because of the technical importance of cesium arcs for the development of energy converters and the presence in the literature of discordant data, particularly concerning electron temperatures. The electrodes were of molybdenum; the 4×4 mm^2 working faces were plane and parallel. The cathode was of foil and was heated by direct current. The arc parameters were varied over the following ranges: electrode spacing, 0.5–2 mm; cathode temperature, 1400–1800°K; cesium vapor pressure, 0.5–5 mm Hg; current density, 2–20 A/cm^2. The dispersion of the type DFS-12 spectrometer was 5 amp/mm in the second order (3000–6000 A) and 10 amp/mm in the first order (6000–12,000 A). The FEU-38 photomultiplier employed to record the spectra was sensitive from 3000 to approximately 9000 A. The arc was

imaged at unit magnification on the spectrometer slit, which was parallel to the plane of the electrodes; conditions in the arc could thus be observed between the electrodes at different distances from them. Many cesium lines were observed in the spectrum. Electron temperatures were determined from line intensities in the sharp and diffuse series; the intensities were consistent with Boltzmann distribution of the level populations. The electron temperatures ranged from 1200 to 3000 or 4000°K. Electron concentrations were derived from the Stark broadening of lines of the fundamental series; electron concentrations of the order of 10^{14} or 10^{15} cm^{-3} were observed. A number of forbidden lines were recorded. Electron concentrations derived from the forbidden line intensities were considerably lower than those derived from the Stark broadening. In low current arcs the electron temperature increased almost linearly with distance from the cathode throughout the whole electrode gap. In higher current arcs the electron temperature at first increased more rapidly with distance from the cathode than in low current arcs, but this increase did not persist throughout the full gap and the electron temperature was nearly constant throughout most of the arc. The spectrum lines were most intense in a region of the arc somewhat closer to the cathode than to the anode. The electron density was maximum at a short distance from the cathode. The position of the electron density maximum shifted toward the cathode with increasing arc currents, and at the highest currents the presence of a maximum could not be established. The physical mechanisms responsible for the observed distributions are discussed briefly but no definite conclusions are reached. The fact that the maximum electron temperature and maximum electron density occur in different regions of the arc is difficult to explain without invoking stepwise ionization processes. (ATD)

34762 CHARGE RECOMBINATION DURING DECAY OF A PLASMA IN HELIUM OR ARGON AT HIGH PRESSURE WITH AN ADMIXTURE OF CESIUM VAPOR. Morgulis, N. D.; Polushkin, I. N. (Kiev State Univ.). Zh. Tekh. Fiz., 36: 542-8(Mar. 1966). (In Russian).

As the first stage of an investigation of discharge plasmas in inert gases containing small admixtures of alkali metal vapors, the decay of helium and argon plasmas containing cesium was investigated. The plasmas were produced in 1-cm diameter, 20-cm long sealed glass tubes containing helium or argon at 100–150 mm Hg by discharge of a 5-kv, 10-μF capacitor. The partial pressure of cesium in the discharge tube was varied from 10^{-8} to 0.1 mm Hg by adjusting the temperature of a side tube containing metallic cesium. Spectra of continuous arc discharges were observed and electron temperatures were derived from line intensity ratios. When the cesium pressure was high (e.g., 0.02 mm Hg), only cesium lines were observed, suggesting that the plasma consisted entirely of ionized cesium in a neutral inert gas. At very low cesium concentrations the inert gas spectrum was prominent. An electron temperature of 3000°K was obtained in a 5 amp/cm^2 arc in helium at 110 mm Hg containing cesium at 0.02 mm Hg. The ion density during decay of the plasmas was determined from the positive current to cylindrical probes. That the plasma decay was due almost entirely to volume recombination, as was expected because of the high inert gas pressure, was shown by the fact that the reciprocal of the ion density increased linearly with time. The volume recombination coefficient was found to be close to 4×10^{-10} cm^3/sec whenever the cesium pressure exceeded a critical value (about 10^{-4} mm Hg in helium and 10^{-5} mm Hg in argon). Whenever the cesium pressure was below this critical value the recombination coefficient was close to 3×10^{-9} cm^3/sec in the helium mixtures and 4×10^{-7} cm^3/sec in the argon mixtures. In at least one experiment with approximately the critical concentration of cesium, the decay curve (reciprocal ion density versus time) consisted of two straight lines with different slopes joined by a short knee. The fact that the cesium recombination coefficient is the same in the presence of a large excess of inert gas as in pure cesium vapor and remains unchanged over a wide range of ionization indicates that molecular ions do not play a significant role in cesium recombination. It is suggested that cesium recombination is effected mainly in three-body collisions between an ion and two electrons. The recombination coefficients observed for helium and argon are too large to be accounted for by analogous three-body collisions, however, and it is suggested that molecular ions participate in the inert gas recombination process. (ATD)

34763 DIFFRACTION OF ELECTROMAGNETIC WAVES BY A METALLIC GRATING MOUNTED ABOVE AN INFINITE PLASMA. Baregamyan, V. A. (Kharkov Inst. of Mining Machinery Construction, Automation, and Computing Tech.). Zh. Tekh. Fiz., 36: 571-3(Mar. 1966). (In Russian).

The diffraction of plane polarized electromagnetic waves normally incident from vacuum onto an infinite plane grating of identical equally spaced perfectly conducting strips mounted parallel to and at a finite distance from the plane boundary of a semi-infinite plasma. The space between the plasma and the grating is assumed to be filled with a dielectric material characterized by a scalar dielectric constant. The incident wave is resolved into its circularly polarized components and the amplitudes are expanded in Fourier series with the period of the grating. The boundary conditions lead to a Riemann-Hilbert problem that has been previously solved. With the aid of this solution and related results, equations are derived for the reflection coefficients for the two circularly polarized components. One can employ these equations to calculate the charged particle density in the plasma from measured reflection coefficients. (ATD)

34764 RELAXATION PROCESSES IN QUANTUM PLASMAS. Zachary, Woodford William. College Park, Md., Univ. of Maryland, 1965. 221p.

Thesis.

A theory of quantum statistical mechanics is developed by means of a somewhat different formulation in terms of Green's functions or propagators. The unusual feature is that the method is based upon the analytic properties of two-particle propagators instead of single-particle propagators. The theory is developed in detail for two physical systems—the electron gas and the electron-ion gas—although the generality of the method is briefly discussed. Relaxation times for various processes are calculated by formulating the theory in terms of the electron density variation, i.e., the difference between the actual electron density and the equilibrium electron density. The objective of this procedure is to delineate the region of validity of the relaxation time hypothesis as commonly used in phenomenological theories. Detailed results are obtained in the lowest order approximation, the so-called random phase or self-consistent field approximation. The generalization to higher order approximations is straightforward in principle and is briefly discussed. It is found that the relaxation time hypothesis is valid for the plasmon, phonon, and particle-hole continua contributions to the electron density variation, but not for the exchange effect between noninteracting particles. It is also shown that this contribution cannot properly be interpreted as an exchange effect because it does not vanish in the classical limit. More general derivations are given for the dispersion relations and damping of the collective modes, the plasmon and phonon. The hierarchy of relaxation times for the various contributions to the density variation is considered in the region of long wavelengths. It is shown that the hierarchy has different patterns for collective states than for single-particle-like states. (TCO)

34765 STUDY OF THE CESIUM PLASMA. Wendt, John Francis. Evanston, Ill., Northwestern Univ., 1965. 194p.

Thesis.

A cesium plasma, generated by the processes of surface ionization and thermionic emission and contained by an external magnetic field was studied. The plasma exists in a steady state and is quiescent in nature. The energy necessary to support the plasma condition is purely thermal in nature, and no applied electric field is present.

Plasma properties were determined with Langmuir probe techniques. The cesium plasma density could be varied from 7×10^{10} to 6×10^{11} cm^{-3}. Electron temperatures were found to be between 2600° and 3000°K. The degree of ionization varied from 15% to 30%. A theory relating the ion density to the atom density in an alkali-metal-generated plasma was compared with an experiment in which the ion density was varied from 8×10^{10} to 5×10^{11} cm^{-3}, and good agreement was achieved. A study was made of the characteristics of waves generated in the plasma by a grid whose potential was periodically changed. The phase velocity of the waves was shown to be independent of the wave frequency from 10 to 40 kc, independent of the plasma density from 8×10^{10} to 3×10^{11} cm^{-3}, independent of the magnetic field strength from 2000 to 5000 gauss, and a function only of the plasma temperature. These properties are characteristic of ion acoustic waves. The magnitude of the phase velocity exceeded the theoretically predicted value for ion acoustic waves by 40%. The wave attenuation, which was extremely rapid, was also measured. The inverse of the damping distance varied linearly with frequency and increased with an increase in the plasma density. The measurements were compared with both a collisionless and a collisional wave theory and it was demonstrated that two damping mechanisms were operating — Landau damping and ion-atom collisional damping. The effect of these two mechanisms could be separated. The dimensionless damping due to the Landau mechanism was found to be 0.45 ± 0.10, in good agreement with the theoretical value of 0.39. (Dissertation Abstr.)

34766 PRECURSOR STUDIES IN AN ELECTROMAGNETIC SHOCK TUBE. Lubin, Moshe Joel. Ithaca, N. Y., Cornell Univ., 1966. 94p.

Thesis.

Precursor waves were studied in an electromagnetic shock tube of the T configuration. The precursor velocity, electron density structure, and current content were determined over a pressure range of 1 to 1000 microns Hg, for electrode discharge voltages of 3 to 17 kv in hydrogen and argon. A longitudinal nanosecond microwave pulse technique was developed to measure the velocity and gross precursor electron density structure. Precursor velocities of 2×10^7 to 5×10^8 cm/sec, and average electron densities of 10^{10} to 3×10^{11} elec/cm^3 were observed. The detailed electron density profile was determined by a transverse, semi-infinite microwave cavity technique showing a sharp electron density jump associated with the precursor front, rising to peak electron density in 2 to 5 cm. The current associated with the precursor was inferred from transverse magnetic field measurements made with an external pickup coil. The current measurements indicate a generally uniform current density from the precursor front on back to the discharge region with the total current in the precursor of the order of a few amperes. The overall shock tube behavior was established by means of photomultiplier tubes that recorded the luminescence associated with the main shock region and by standard current and voltage measuring techniques. A Kerr-cell photograph of the shocked region was also used to check the overall behavior. The discussion of the precursor behavior is presented and compared with the nonlinear development of an ionizing electromagnetic wave. The electromagnetic shock tube is treated as a transmission line and the nonlinearity of the medium is expressed in terms of the ionization in the gas. Reasonably good agreement, between the measured precursor velocities, precursor velocity dependence on pressure and discharge field, with the transmission line model is obtained over the whole operating range. The precursor development relative to the shock wave is discussed for the above range of parameters. (Dissertation Abstr.)

34767 ION-ACOUSTIC WAVES IN A ONE-DIMENSIONAL PLASMA MODEL. Isham, Elmer Rex. College Station, Tex., Texas Agricultural and Mechanical Univ., 1965. 122p.

Thesis.

The results of a one-dimensional plasma model are compared with theoretical results to show the existence of ion-acoustic waves in the model. The dispersion relations for the ion-acoustic and plasma modes of longitudinal oscillation are obtained. In particular, the dispersion relation for ion-acoustic waves is derived for the ion-acoustic wave length greater than the ion Debye length but less than the electron Debye length. In addition, the autocorrelation functions of the spatial Fourier transform of the electron, ion, and charge densities are calculated, and it is found that the electron and charge density autocorrelation functions are dominated by the high-frequency plasma oscillations, whereas the ion density autocorrelation functions are dominated by the low-frequency ion-acoustic waves. In order to check the theoretical results, a one-dimensional plasma model consisting of 300 particles — 150 electrons and 150 ions — with $m_+ = 50\ m_-$ and $T_- = 10\ T_+$ is set up in the IBM 7094 computer. The autocorrelation functions obtained from the model behave as the theory predicted. (Dissertation Abstr.)

34768 EQUILIBRIUM CONDITIONS AND BEAM FOCUSING EFFECTS IN A BEAM-GENERATED PLASMA. Halsted, Stevens. Stanford, Calif., Stanford Univ., 1965. 147p.

Thesis.

A static theory for a beam-generated plasma in cylindrical geometry is presented, which assumes radial drainage of the ions to the wall. Exact solutions for the plasma density and potential distribution valid throughout the plasma and sheath are given. It is shown that a knowledge of either the plasma electron temperature or the axial electron density in an experiment is normally sufficient to determine a unique set of equilibrium conditions. When the beam only partially fills the space, a low-potential sheath forms at the edge of the beam, which is separated by a region of slowly varying potential from a second, higher-potential sheath at the wall. The plasma density at the beam edge is less than half the value on the axis. The electrostatic potential within the plasma is found to have a shape such that an inward force acts on the beam electrons that generate the plasma. Such an electrostatic pinch is shown to account for the gas focusing or ion focusing of electron beams often observed experimentally. Experimental data are presented on pinched beams, and the theoretical and experimental results are shown to be in good agreement. Methods of establishing and controlling pinched electron beams are discussed. Finally, a beam-generated plasma is examined by simulating the motion of the individual ions and electrons on a computer. This method permits following of the evolution of the system in time to its steady state without presupposing a static solution or the eventual form of the ion and electron density distribution. The system does not settle to a d-c state, but exhibits fluctuations at the electron plasma frequency, which randomize the velocities of the plasma electrons. The time-average of the potential and density distribution agrees well with that obtained from the static theory. The computer experiment approach appears to be a promising method of investigating basic randomization processes in plasmas. (Dissertation Abstr.)

34769 (I) ION TEMPERATURE DETERMINATION BY MEASUREMENT OF DOPPLER BROADENING OF H_α LINE IN A PLASMA. (II) SHIELDING EFFECT ON THE RF POWER. (III) IONIZATION BY A HIGH CURRENT PULSE DISCHARGE. Verma, Jal Singh. Columbus, Ohio, Ohio State Univ., 1965. 89p.

Thesis.

Research was carried out on the development of the spectroscopic technique for measurement of ion temperature of the plasma confined in a magnetic mirror system and heated by a two-phase radio-frequency power. The general theory of Doppler broadening of a spectral line that results from the random motion of the ionic particles is presented on the assumption of the validity of Maxwellian distribution of velocities for the ions in the system. Contributions to the line width from causes other than Doppler effect were considered and evaluated. The width of the H_α line emitted by the plasma was measured by a Fabry-Perot

interferometer. The main problem encountered was that of low intensity of the light from the plasma and of instability in adjustment of etalons for parallelism. The use of a fast film was essential. The presence and the effect of an electrostatic field along the length of the r-f coil in the r-f system were studied. The electrostatic field is a result of the potential difference between the ends of the r-f coil. The presence of this field partially hinders the r-f power in entering into the plasma region. A plasma of hot electrons and cold ions results. The electrostatic field was minimized by means of a grounded shield of copper strips between the r-f coil and the plasma bottle. An effect of current in the copper strips, called Ioffe strips, was studied. A high current pulsed discharge was used for producing a high degree of ionization. The use of low inductance capacitors and a low inductance circuit makes possible discharge currents of the order of 26,000 amperes for about 75 microseconds through the plasma bottle. The ionization along the path of the current between two electrodes was about 100 percent. The problem of sputtering was minimized by the use of aluminum electrodes. An ignitron, capable of 60,000 amperes for 120 microseconds, was used as an on-off switch for handling the high currents in the circuit. In this process nearly all the energy is carried by the electrons and not by the ions. (Dissertation Abstr.)

34770 SMALL DISTURBANCIES IN PLASMA WITH THE VOLUME SOURCES OF ENERGY. Shulman, L. M. pp 10-37 of Fizika Zvezd i Mezhzvezdnoi Sredy. Bogorodskii, A. F. (ed.). Kiev, Izdatel'stvo Nauka Dumka, 1966. (In Russian).

The dispersion properties of a plasma in external magnetic and gravitational fields are investigated, taking the presence of volume sources and sinks of energy into account. Some cases where a simple solution of the dispersion equation is possible are considered in detail. The coefficients of refraction for acoustic and magneto-acoustic waves are computed for cases of astronomical interest. The results are applied to the theory of acoustic heating of the chromosphere. Calculations show that specific absorption associated with radiative losses is capable of producing sufficient dissipation of the acoustic waves in the solar chromosphere. (auth)

34771 ELECTRIC AND MAGNETIC FIELD DISTRIBUTIONS IN A PROPAGATING CURRENT SHEET. Burton, Rodney L.; Jahn, Robert G. (Princeton Univ., N. J.). New York, American Inst. of Aeronautics and Astronautics, 1966, Preprint No. 66-200, 22p., $1.50. (CONF-660310-18). ORAU.

From AIAA 5th Electric Propulsion Conference, San Diego, Calif.

The structure of a radially propagating current sheet in a 5-inch diameter pinch discharge in argon is studied experimentally with conventional magnetic and electric probes. A 5 turn, 2 mm diameter probe coil is used to map azimuthal magnetic field over the entire pinch chamber, from which patterns of axial current density are extracted. A coaxial double Langmuir probe of 2 mm electrode separation is used to determine radial and axial electric fields. A radial electric field in excess of 10^4 v/m is found inside the current sheet, a value sufficient to allow conduction of axial current by electrons in $\vec{E}_r \times \vec{B}_\theta$ drift. This radial electric field is also adequate to accelerate argon ions to sheet velocity. The magnitude of the axial electric field is essentially equal to $u_s B_\theta$, so that a particle moving with sheet velocity u_s sees an electric field which is almost purely radial. The indicated model of primarily axial electron current and radial argon ion streaming is supported by photographic observations and is consistent with particle orbit calculations based on the prevailing parameters. (auth)

34772 DOPPLER MEASUREMENTS OF THE KINETIC ENERGIES PRODUCED IN RADIO FREQUENCY PLASMOIDS. Trimmier, J. Robert; Miller, August (New Mexico State Univ., University Park). 13p. (CONF-660107-38). ORAU. Gmelin, AED-CONF-66-003-49.

From American Physical Society Meeting, New York.

A radio frequency plasmoid is briefly described. A description of some experiments which have been conducted with respect to the constituent particles of the discharge is presented. Measurements of the kinetic energies of the atoms, ions, and molecules by measuring Doppler width of the emission lines are reported. (B.G.D.)

34773 NONLINEAR OPTICAL EFFECTS IN PLASMAS. Kroll, Norman M. (Univ. of California, San Diego, La Jolla). 29p. (CONF-650638-6). ORAU. Gmelin, AED-CONF-65-156-14.

From Physics of Quantum Electronics Conference, San Juan, Puerto Rico.

The theory of three-field mixing is extended to include the effects of convective nonlinearities on the plasma excitation. As might be expected, these lead to the saturation of the excitation as the oscillation of the electron density approaches the mean density in amplitude. For the particular parameters chosen by Kroll, Ron, and Rostoker, it is much more important than the collisional and Landau damping in limiting the plasma oscillation, and reduces the intensity of the scattered radiation there quoted by two orders of magnitude. The onset of saturation can be delayed and conditions for the observation of three-field mixing considerably improved in other ways as well by operating at higher plasma densities and taking advantage of the propagation characteristics of the plasma excitation. Classical effects associated with the nonlinear interaction of two light beams and reminiscent of light by light scattering arise as the result of the combined effect of fluctuation scattering and the fourth rank susceptibility tensor. The effect can also be described as arising from simultaneous coherent coupling of both incident light beams with a particular excitation mode of the scattering medium, leading to a gain constant which depends upon a linear combination of the incident intensities. Under certain rather special conditions, it can be a large effect and appear as the most prominent nonlinear process. A classical interpretation is found for thermally enhanced light by light scattering. The classical quantity involved is the correlation function of the spectral densities of the incoherent scattering from the two beams. It does not depend upon the nonlinear properties of the medium. (auth)

34774 ARRANGEMENT FOR PRODUCTION OF A HIGH-ENERGY PLASMA BY MEANS OF AN ELECTRIC ARC. Jaatinen, Walter Andrew; Chappel, Raymond Mark; Rowland, Wilfred (to Vitro Corp. of America). German Patent 1,214,332. Apr. 14, 1966. Priority date Apr. 19, 1962, United States.

The plasma source comprises a cathode having a tapering surface projecting forward of an anode the surface of which is of annular form and means for introducing a fluid flow adjacent to the tapering surface of the cathode. The anode surface is the forward, narrower-diameter and surface of a hollow truncated cone of conducting material constituting the anode. The anode and the cathode are concentric bodies, the anode lying behind the base of the conical cathode portion. (Gmelin Inst.)

34775 CLOSED PATH PLASMA ACCELERATOR. Fonda-Bonardi, Giusto (to Litton Systems, Inc.). U. S. Patent 3,252,047. May 17, 1966. Filed Dec. 6, 1960.

A closed path accelerator is provided in which the plasma particles are accelerated angularly about a closed path rather than along a linear path to enter a region with a predetermined velocity. The plasma particles recirculate cyclically about the closed path and are continuously subjected to the accelerating forces with the ultimate speeds of the particles not being limited by the accelerator length nor the accelerating force. The kinetic energy of that fraction of the plasma particles which have not reacted is conserved since the curvature of the closed path maintains the unreacted particles in the reactor region. The curved path is achieved by the application of a radially directed inward force generated by a magnetic field to the plasma particles for balancing the centrifugal force applied to them as a result of the peripheral speed and curved path of the plasma particles. A tangential force generated by a rotating magnetic field is applied to the plasma particles to accelerate

the particles for bringing them up to the desired speed after which they circulate about the closed path at the desired speed. Two such accelerators are positioned relative to each other so that their paths intersect to form a reaction region where the particles traveling along the paths of one accelerator collide with those travelling along the path of the other accelerator, and the relative velocities of the particles are sufficient to insure that the particles experiencing collision fuse together to release energy in excess of that needed to accelerate the plasma particles to establish a self-sustaining fusion type reactor. (B.L.M.)

34776 METHOD OF CONTROLLING PLASMA STABILITY. Post, Richard F. (to U. S. Atomic Energy Commission). U. S. Patent 3,257,284. June 21, 1966.

A method for controlling the destructive "flute" or hydromagnetic interchange instability which occurs in magnetically confined, single species, high-temperature plasmas. The method comprises introducing higher energy and higher mass number additive particles into the plasma to improve the cohesiveness of the plasma. The enhanced "finite orbit" effect of the additives tends to suppress the "flute" instability. (AEC)

34777 METHOD FOR REVERSIBLY EXTRACTING ENERGY FROM A PLASMA BY MAGNETIC PUMPING. Hall, Laurence S. (to U. S. Atomic Energy Commission). U. S. Patent 3,260,869. July 12, 1966.

A method for extracting energy from a plasma which comprises imposing on the plasma a constricting magnetic field which varies in a nonsinusoidal manner, i.e., time-sequence saw-tooth profile, is considered. More specifically, the resistance of the magnetic field is made substantially greater than the fall time of the field and of the cyclotron period of the plasma ions, and particularly with the fall time substantially less than the ion transit time and the mean time interval between successive ion collisions productive of a 90° deflection of an ion. The work done by the plasma against the magnetic field induces an electromotive force in the magnetic field coil, allowing the energy to be extracted by means of a suitable load connected to the coil with improved thermodynamic efficiency. (AEC)

Shielding

34778 (N-65-32252) RADIATION PHYSICS RESEARCH AT MSFC: RESEARCH ACHIEVEMENTS REVIEW SERIES. Shelton, Russell D. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). July 1, 1965. 39p. (NASA-TM-X-53301). CFSTI $2.00 cy, $0.50 mn.

The status and accomplishments of the Marshall Space Flight Center research program in the area of radiation physics are presented. It relates in general terms the MSFC research effort concerned with radiation effects upon materials, testing of electronic components in radiation fields, shielding from nuclear and space radiation, plasma physics, and electromagnetic shielding. It describes the MSFC research facilities for radiation physics. References include the major MSFC research contracts and publications in the field of radiation physics. (auth)

34779 (N-66-12185) INVESTIGATION OF BREMSSTRAHLUNG PRODUCTION IN A SHIELDING MATERIAL. (Advanced Research Corp., Atlanta, Ga.). May 1965. Contract NAS8-11083. 16p. (NASA-CR-68107). CFSTI $1.00 cy, $0.50 mn.

Shielding effects of an infinite slab embedded in an isotropic electron source were studied. A model was derived from calculations on the electron source spectrum, the electron penetration, the Bremsstrahlung production, the photon penetration, and the flux-to-dose conversion. Considered were the following assumptions for the electron and photon penetrations: straight-ahead, continuous slowing down of the penetrating electrons; straight-ahead Bremsstrahlung production; and a plane source of isotropic radiation at each depth x. Preliminary calculations were made for an aluminum slab having a thickness of 4 gm/cm^2 by performing a five-point Gaussian quadrature over the angle of photon momentum, followed by a nine-point trapezoidal integration over x. The relative importance of the electron contributions from various parts of the Bremsstrahlung production cross section were determined by summing the contributions from the regions of interest and subsequent comparison with the total dose rate. Results are given for the dose rate of Roentgens per hour. (STAR)

34780 (N-66-13563) AN ANNOTATED BIBLIOGRAPHY ON MOTION OF CHARGED PARTICLES IN MAGNETIC FIELDS AND MAGNETIC SHIELDING AGAINST SPACE RADIATION. McDonald, Perry F. (Brown Engineering Co., Inc., Huntsville, Ala. Research Labs.). Nov. 1965. Contract NAS8-20166. 44p. (NASA-CR-68657; R-161). CFSTI $2.00 cy, $0.50 mn.

An annotated bibliography is presented on the theory of charged particle motion in magnetic fields and the shielding against charged particle radiation using magnetic fields. Topics included are: general references on charged particle motion and cosmic rays, motion of untrapped particles in magnetic fields, motion of trapped particles in magnetic fields, ring currents in the magnetosphere, and space radiation shielding using magnetic and electric fields. It should be helpful to those interested in the interaction of cosmic rays and energetic solar particles with the geomagnetic field and those interested in the active methods of shielding against space radiation. (auth)

34781 (N-66-16495) SHIELDING ANALYSIS OF 1956–1961 SOLAR PROTON EVENT DATA. Haffner, J. W. (North American Aviation, Inc., Downey, Calif. Space Sciences Lab.). July 15, 1964. 39p. (SID-64-1295).

Since it is the large solar particle events which constitute the major high energy radiation hazard to extended space travel, an analytical study of the characteristics of the protons observed during these events was carried out. By mathematically fitting the statistically average proton fluxes of such large events, reasonable time and energy behaviors were found. Combining this with a flux to dose conversion function and making use of two almost compensating assumptions yielded an accurate attenuation kernel useful for thickness 0–30 gm/cm^2 of / material. (auth)

34782 (NAA-SR-Memo-11718) THE DTF-II SHIELDING DATA LIBRARY. Green, W. B. (Atomics International, Canoga Park, Calif.). Nov. 2, 1965. Contract AT (11-1)-Gen-8. 105p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

A new data library is available for use with the DTF-II S_N theory transport code in computing neutron fluxes in shield systems and reactor criticality. Two group structures are available: a 21 group structure with nine energy groups in the .41 to 14.9 Mev range (primarily for use in shielding problems) and a 16 group structure (suitable for use in criticality calculations). The epithermal data for both group structures were obtained by group averaging pointwise data over a typical SNAP spectrum using the GAM-II code. Data for the thermal range were taken from previously generated data libraries at Atomics International. The available materials, the generation of the library data, and information for those wishing to use this library in DTF calculations are described. A complete listing of the library data is also included. (auth)

34783 BACKSCATTERING OF LOW-ENERGY GAMMA RAYS. Pozdneev, D. B. At. Energ. (USSR), 20: 317-23 (Apr. 1966). (In Russian).

The spectral angular distributions of inverse γ scattering on paraffin, graphite, Al, Cd, Fe, Pb, and Zn (semi-infinite media) were measured using a point-source isotope geometry. The results were in good agreement with values calculated by the Monte Carlo method. (G.O.Y.)

34784 PENETRATION OF HIGH-ENERGY NEUTRONS THROUGH IRON–WATER MIXTURES. Sychev, B. S.; Mal'kov, V. V.; Komochkov, M. M.; Zaitsev, L. N. At. Energ. (USSR), 20: 323-7(Apr. 1966). (In Russian).

The yield of delayed neutrons (E < 1 Mev) accumulated during high energy neutron penetration through iron and iron–water mixtures was measured and was also studied

theoretically. The data were used to design shielding made of heavy concrete and iron–concrete mixtures. It was found that accelerator shielding made out of iron without hydrogen was unsatisfactory. (G.O.Y.)

34785 ENERGY BUILDUP FACTORS FOR COSINE SOURCES IN IRON AND LEAD. Panchenko, A. M. At. Energ. (USSR), 20: 351-2(Apr. 1966). (In Russian).

The energy buildup factors of iron and lead were investigated for disk and infinite plane sources whose angular distribution of radiation follows a cos θ or a $\cos^2 \theta$ law. (G.O.Y.)

34786 BACKSCATTERING OF LOW-ENERGY GAMMA RAYS FROM FINITE BARRIERS. Pozdneev, D. B.; Churin, S. A. At. Energ. (USSR), 20: 352-4(Apr. 1966). (In Russian).

The differential albedo of Al, Cd, graphite, and Fe was measured for low-energy gamma rays from point sources of ^{141}Ce, ^{51}Cr, ^{203}Hg, ^{114}In, and ^{95}Nb. (G.O.Y.)

34787 PENETRATION OF HIGH-ENERGY NEUTRONS THROUGH HEAVY CONCRETE. Sychev, B. S.; Mal'kov, V. V.; Komochkov, M. M.; Zaitsev, L. N. At. Energ. (USSR), 20: 355-6(Apr. 1966). (In Russian).

The penetration of high-energy (E > 100 Mev) neutrons through heavy (hematitic) concrete with various contents of hydrogen was investigated. (G.O.Y.)

34788 OPTIMIZATION OF A SHIELD AGAINST A RADIATION MIXTURE. Krueger, F. W. (VEB Atomkraftwerk, Berlin). Kernenergie, 9: 165-8(May 1966). (In German).

A plane source of radiation is supposed to emit two kinds of radiation which are shielded by a wall of two materials. The conditions for the maximum efficiency of this shield are given presuming that the mass per unit area or the thickness of the wall is well known. The results are explained by some examples. (auth)

34789 MEASUREMENTS OF DOSE BUILDUP FACTORS IN SLAB MATERIALS FOR ^{60}Co ISOTROPIC SOURCE. Kanemori, Yoshihiko (Mitsui Shipbuilding and Engineering Co., Ltd., Japan). Nippon Genshiryoku Gakkaishi, 8: 304-8(June 1966). (In Japanese).

Gamma-ray transmission dose rates were measured for the case where the line connecting a ^{60}Co point isotropic source and the detector center lies obliquely against the absorber plane, to derive the relation between dose buildup factors and the oblique angles between the connecting lines and the absorber plane. The slab materials taken up were aluminum, iron, and lead. In addition, transmission dose rates for a line isotropic source were obtained by numerical integration of the measured dose rates for point sources, sources, and relations similar to the case of point source were derived between dose buildup factors and oblique angles. Dose buildup factors for a plane isotropic source were also determined. (auth)

34790 ATTENUATION OF NITROGEN-CAPTURE GAMMA RAYS BY CONCRETE SLAB SHIELDS. Johnson, W. Reed (Univ. of Virginia, Charlottesville); Risher, D. H.; Spessard, R. L. Trans. Amer. Nucl. Soc., 9: 140 (June 1966).

34791 GAMMA ATTENUATION IN LITHIUM HYDRIDE–HEAVY METAL SHIELDS. Thiele, A. W. (Atomics International, Canago Park, Calif.); Golliher, K. G.; Randen, K. G. Trans. Amer. Nucl. Soc., 9: 141(June 1966).

34792 DECAY GAMMA-ENERGY RELEASE RATE FOLLOWING A REACTOR TRANSIENT. Warkentin, J. K.; Matheney, G. B. (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 9: 141-2(June 1966).

34793 COMPARISON OF MONTE CARLO CALCULATIONS AND THRESHOLD FOIL MEASUREMENTS OF 14-Mev NEUTRON ATTENUATION IN BORATED POLYETHYLENE. Wood, D. E.; Heagerty, D. E. (Kaman Aircraft Corp., Colorado Springs, Colo.). Trans. Amer. Nucl. Soc., 9: 142-3(June 1966).

34794 SPECTRAL DISTRIBUTION OF FISSION NEUTRONS IN ORDINARY CONCRETE. Lim, M. Gene (Westinghouse Electric Corp., Pittsburgh); Johnson, W. Reed; Williamson, T. G. Trans. Amer. Nucl. Soc., 9: 143-4(June 1966).

34795 PRIMARY PROTON DOSE FORMULAS. Leffler, J. M. (North American Aviation, Downey, Calif.). Trans. Amer. Nucl. Soc., 9: 144(June 1966).

34796 NEUTRON ALBEDO FOR THIN WALLS. Doty, D. R. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Trans. Amer. Nucl. Soc., 9: 145 (June 1966).

34797 CALCULATION AND MEASUREMENT OF THE DIFFERENTIAL ANGULAR CURRENT ALBEDO FOR SUBCADMIUM NEUTRONS EMERGENT FROM CONCRETE DUE TO INCIDENT MONODIRECTIONAL BEAMS OF EPICADMIUM NEUTRONS. Coleman, W. A.; Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 146(June 1966).

34798 VARIATION OF DOSE ATTENUATION OF TWO LEGGED CONCRETE AND STEEL DUCTS WITH INCIDENT GAMMA-RAY ENERGY. Chapman, J. M. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Trans. Amer. Nucl. Soc., 9: 146-7(June 1966).

34799 CALCULATION OF THE FAST-NEUTRON DOSE RATE ALONG THE CENTER LINE OF BOTH A STRAIGHT AND A TWO-LEGGED SQUARE CONCRETE DUCT USING THE ALBEDO CONCEPT AND COMPARISON WITH EXPERIMENT. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 147-8(June 1966).

34800 INVESTIGATION OF THE FLOOR-BARRIER REDUCTION FACTOR USED IN STRUCTURE SHIELDING THEORY. Kaplan, Arthur L. (Technical Operations Research, Burlington, Mass.). Trans. Amer. Nucl. Soc., 9: 148-50(June 1966).

34801 DESIGN OF STRUCTURES FOR PROTECTION FROM WINDOW-COLLIMATED, CEILING-SCATTERED FALLOUT RADIATION. Iotti, Robert C.; Baran, James A.; Faw, Richard E.; Mingle, John O.; Kimel, William R. (Kansas State Univ., Manhattan). Trans. Amer. Nucl. Soc., 9: 150-1(June 1966).

Solid State Physics

See also CHEMISTRY — Inorganic and Physical Chemistry
METALS, CERAMICS, AND OTHER MATERIALS — Properties and Structure

Refer also to abstracts 33306, 33384, 33684, 34423, 34630, and 34764.

34802 (ANL–7147) MODULATED RECIPROCAL CRYSTAL-LATTICE AND DIFFRACTOMETRIC COMPUTER PROGRAM. Atoji, Masao; Gvildys, J. (Argonne National Lab., Ill.). Jan. 1966. Contract W-31-109-eng-38. 31p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The diffraction optics for all the conceivable modulations on the fundamental reciprocal-crystal lattice are interpreted in terms of a simple universal concept, the modulation reciprocal-lattice vector. The physical significance of this modulation vector is discussed in the following selected topics: the antiphase domain structure, the modulated magnetic-spin alignment, the structure imperfection, and the thermal diffuse scattering. Also presented is a computer program for calculating the basic diffractometry parameters for the modulated lattice and the crystal-detector setting angles in the four-circle, normal-beam, equatorial technique. The computer program, as well as our discussions on the modulation vector, are applicable to the x-ray, neutron, and electron-diffraction methods. (auth)

34803 (BNL–940) SYMPOSIUM ON INELASTIC SCATTERING OF NEUTRONS BY CONDENSED SYSTEMS HELD AT BROOKHAVEN NATIONAL LABORATORY, SEPTEMBER 20-22, 1965. (Brookhaven National Lab., Upton, N. Y.). Mar. 1966. Contract AT(30-2)-Gen-16. 205p. (CONF-650932). Dep. mn. CFSTI $6.00 cy, $1.25 mn.

The conference included 28 papers, 7 of which appeared previously in NSA as 19: 26668, 46232, 47572, and 47879 and 20: 10865, 16461, and 20107. Separate abstracts were prepared for 21 papers. (J.F.P.)

For abstracts of individual papers see: 33253–33255, 33320, 33617, 34327–34329, 34414, 34468, and 34804–34814.

34804 (BNL–940, pp 1-7) COMPARISON OF ELECTROMAGNETIC AND NEUTRON STUDIES OF SOLIDS. Blume, M. (Brookhaven National Lab., Upton, N. Y.).

Experiments involving electromagnetic radiation are considered and compared with neutron scattering experiments with emphasis on the scattering experiments. These experiments can be expressed in terms of time-dependent correlation functions. The usefulness of neutrons in studies of thermal and magnetic properties of solids compared with the usefulness of photons is emphasized. (J.F.P.)

34805 (BNL–940, pp 8-15) REVIEW OF EXPERIMENTAL MEASUREMENTS OF LATTICE MODES IN TRANSITION METALS. Woods, A. D. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.).

The measured frequency (ν) versus wave vector (q) dispersion relations for niobium and tantalum (column V of the periodic table) are similar to one another, as are those for chromium, molybdenum, and tungsten (column VI). However, ν(q) for the column V metals are qualitatively different from those for the metals of column VI, suggesting that the dispersion relations are determined largely by the electronic structure through the electron-phonon interactions. The Λ_1 branch ($\Gamma \rightarrow P \rightarrow H$) was studied in considerable detail and displays one very striking and other smaller anomalies in both Nb and Mo. It is believed that these anomalies are manifestations of the Kohn effect; their positions correlate well with Fermi surface dimensions deduced from band structure calculations and from direct measurements on tungsten. Measurements on disordered alloys of the two materials indicate that the neutron groups for the phonons are not significantly broader than those for the pure metals, suggesting that the alloys may be treated in the same way as the pure metals but with their own characteristic electronic structure. The altered positions of suspected Kohn anomalies, and the average change in normal mode frequencies, can be correlated, on the assumption of the validity of the rigid band model, with calculations of the band structure and of the density of states for tungsten. (auth)

34806 (BNL–940, pp 23-8) IMPURITY AND ANHARMONIC EFFECTS IN NEUTRON SCATTERING BY PHONONS. Elliott, R. J. (Oxford Univ. (England)).

A theoretical discussion of impurity and anharmonic effects on neutron scattering by phonons is given. It is concluded that although these effects are different in detail their qualitative form is similar. They change the one-phonon scattering cross sections from δ functions to lines of finite width somewhat shifted in position. The tails of these lines have specific shapes and are cut off at the high frequency end. (J.F.P.)

34807 (BNL–940, pp 29-43) ELECTRONIC EFFECTS ON LATTICE VIBRATIONS. Sjoelander, Alf (Chalmers Tekniska Hogskola, Goteborg (Sweden). Institutionen for Teoretisk Fysik).

A review of recent work on lattice vibrations in metals and semiconductors is given with particular emphasis on the role played by the valence and conduction electrons. For metals the effective ion-electron interaction and the screening from conduction electrons is discussed with reference to recent work of Toya, Sham, Harrison, Vosko, and others. Atomic vibration is discussed on the basis of the shell model, and the work particularly of Cochran, Cowley, and Lax is referred to. The various effects are illustrated with figures showing experimental and theoretical results. (auth)

34808 (BNL–940, pp 44-8) LATTICE DYNAMICS AND PHASE TRANSITIONS. Boccara, N. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The case in which lattice dynamics dominates in the occurrence of a transition in crystalline solids is considered. The main experimental facts are reviewed, and some of the most recent theoretical suggestions for explaining the facts and predicting new features of the transitions are presented. Also the main physical ideas and the predictions of a previous self-consistent theory are given. (J.F.P.)

34809 (BNL–940, pp 49-56) CRITICAL PHENOMENA. Mori, Hazime (Research Inst. for Fundamental Physics, Kyoto Univ. (Japan)).

The long-range correlation of spins and anomalous relaxation phenomena in ferromagnets and antiferromagnets near the critical points as typical examples of critical phenomena are discussed. Near the critical point, the correlation of spins becomes long range. This long-range correlation is the origin of all anomalies observed near the critical point. From this point of view and using a fluctuation-dissipation formula, the interpretation of the anomalous relaxation phenomena is explained by taking the spin diffusion process and the line width of the electron spin resonance. It is emphasized that neutron scattering experiments on the spin-pair correlation and longitudinal damping constant below the Curie point are useful, since their behavior is predicted to be different from that above the Curie point. (auth)

34810 (BNL–940, pp 78-82) MEASUREMENTS OF THE FREQUENCIES OF THE NORMAL MODES OF MAGNESIUM. Squires, G. L. (Cambridge Univ. (England). Cavendish Lab.).

The normal modes of magnesium were investigated by means of the inelastic scattering of slow neutrons. The frequencies of about 1000 phonons were measured with a time-of-flight apparatus, and the values along symmetry directions obtained by an interpolation method. It was found that previous results could be fitted by force models extending to fourth-nearest neighbors or less. The present measurements cannot be fitted by any tensor force model extending only to fourth-nearest neighbors. (auth)

34811 (BNL–940, pp 83-7) LATTICE DYNAMICS OF NICKEL AND THE KREBS MODEL. Hautecler, S.; Van Dingenen, W. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)).

The lattice dynamics of nickel was investigated by slow neutron spectroscopy. Phonon spectra were measured, in the (110) plane, by a time-of-flight technique. The incident monochromatic neutron beam is obtained by Bragg reflection, from a Pb single crystal, of a Be-filtered reactor beam. Two hundred phonons were measured under 3 scattering angles (70°, 90°, and 100°). The scattering surfaces and the dispersion curves in the symmetry directions [100], [110], and [111] were deduced from these data. These last experimental results are compared with calculations based on a model proposed by Krebs for face-centered and body-centered cubic metals. A general agreement is found by choosing an appropriate value for the effective number of free electrons. (auth)

34812 (BNL–940, pp 94-5) INELASTIC SCATTERING OF NEUTRONS BY REACTOR TYPE GRAPHITE. Whittemore, W. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The General Atomic neutron velocity selector was used to study the scattering of monoenergetic neutrons in the energy range 0.17 to 0.30 ev by a thin layer of reactor grade graphite. This measurement differs from previous ones in the use of higher energy incident neutrons which can excite directly the crystal energy levels. Egelstaff and Harris, using cold neutrons, found energy levels at 0.08, 0.12, and ~0.18 ev. Their 0.12-ev level is in dis-

agreement with the level 0.108 ev predicted by Young and Koppel. The present data give energy levels at 0.055, 0.08, and 0.12 ev, and a broader level in the range 0.16 to 0.20 ev, in agreement with the predictions of Young and Koppel except for the 0.12-ev level. The data confirm the 0.12-ev level reported by Egelstaff. The effect of coherent scattering to alter peaks in the scattering cross section is believed not to be significant. It appears that some of the force constants of Young and Koppel should be altered (consistent with the correct specific heat) to shift their level from ~0.108 to 0.12 ev. (auth)

34813 (BNL–940, pp 159-62) INELASTIC SCATTERING OF NEUTRONS BY SPIN WAVES IN TERBIUM. Moeller, H. Bjerrum; Mogensen, P. A. (Danish Atomic Energy Commission, Risoe, Research Establishment); Houmann, J. C. Gylden (Tekniske Hoejskole, Copenhagen (Denmark); Kowalska, A. (Copenhagen Univ. (Denmark)).

The spin wave spectrum of terbium was studied by the inelastic scattering of neutrons. A triple-axis spectrometer situated at the DR3 reactor was used for these experiments, and the spin wave dispersion curves were studied in symmetry directions in the hexagonal plane, using the "constant-Q" method with fixed energy of the scattered neutrons. The specimen was a single crystal of pure terbium metal in the approximate form of a cylinder 5 cm long and 6 mm in diameter. It was placed in a cryostat at liquid nitrogen temperature. Well-defined neutron groups were observed for all the Q-values studied. Their amplitude was generally comparable with the background counting rate. From the observed dispersion curves in the $[1,\bar{1},0,0]$ direction, preliminary values of exchange parameters are estimated. (auth)

34814 (BNL–940, pp 169-72) EFFECT OF NUCLEAR SPIN CORRELATION ON THE SCATTERING OF NEUTRONS BY MOLECULES. Sinha, S. K.; Venkataraman, G. (Atomic Energy Establishment, Trombay (India). Nuclear Physics Div.).

The scattering of slow neutrons by molecules is usually discussed without considering the restrictions imposed on the molecular wave functions by the presence of identical nuclei in the molecule. Starting from the work of Zemach and Glauber, the theory of neutron scattering is presented taking into account such effects, with special reference to the spherical top molecule. Matrix elements for the scattering between different symmetrized states are evaluated by group theoretical methods. It is shown that coherent scattering can cause only those transitions which leave the symmetry of the total molecular wave function unchanged, while incoherent scattering can cause transitions between states of different symmetry. The formulas derived for the cross section are different from those obtained in a recent treatment of the same problem. Calculations for methane were made and are compared with the case in which the effects of nuclear spin correlation are ignored. (auth)

34815 (IBK–435) HIGH ENERGY SPUTTERING OF Zn SINGLE CRYSTALS. Perovic, B. D. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). May 1966. 6p. Dep. mn.

An investigation was made in which Zn single crystals were bombarded by Ar^+ ions in the energy range of 1 to 50 kev. The ion current density on the target was between 10 and 30 μ amp/cm^2. The ion beam was exposed to the different crystallographic planes of the hcp lattice of Zn specimens, the basal plane as well as the side planes of the hexagonal prism. The results are presented. (M.O.W.)

34816 (IDO–17170) NEUTRON DIFFRACTION STUDIES OF SAMPLES AT HIGH PRESSURES. Brugger, R. M.; Bennion, R. B.; Worlton, T. G.; Peterson, E. R. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). May 1966. Contract AT(10-1)-205. 56p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

A time of flight method of measuring neutron diffraction patterns was developed for studying samples under high pressures in which a white beam of neutrons is chopped into bursts, then scattered by a powdered sample. The scattered neutrons are observed at two fixed angles of 30° and 90°. The wavelengths of the scattered neutrons are determined by time-of-flight sorting, and peaks are observed in this distribution at wavelengths which satisfy the Bragg condition. Measurements demonstrate the good resolution and good intensities of this method even though the beam area is only 0.4 cm^2. Lattice spacings are measured to an accuracy of 10^{-3} Å while intensities are measured to R ~ 4%. Ways of increasing the intensities and studying single crystals are outlined. A pressure cell capable of containing samples to 15 kbars was used to obtain a diffraction pattern for KNO_3 phase IV and to observe the magnetic reorientation in α-Fe_2O_3 with pressure. A cell that will reach 40 kbars was designed and is being constructed. (auth)

34817 (INR–702/II/PS) ON THE POSSIBILITY OF SIMULTANEOUS STRUCTURE AND LATTICE DYNAMICS STUDIES OF SOLIDS USING THE TIME-OF-FLIGHT METHOD. Buras, Bronislaw (Institute of Nuclear Research, Swierk (Poland). Warsaw Univ. (Poland). Inst. of Experimental Physics). Mar. 1966. 8p. Dep.

A proposal of a method for simultaneous structure and lattice dynamics studies of solids using the time-of-flight technique is described. (auth)

34818 (UCRL–16870) THE NUMERICAL SOLUTION OF THE PROBLEM OF A SLOW CONDUCTION ELECTRON IN AN IONIC CRYSTAL (POLARON). Zimmermann, Walter Stephen (Lawrence Radiation Lab., Univ. of California, Berkeley). Apr. 15, 1966. Contract W-7405-eng-48. 143p. Dep. mn. CFSTI $4.00 cy, $1.00 mn.

Thesis.

The object of the computation is to determine the ground-state energy, E_0, and the effective mass, m*, of the polaron for a range of coupling strengths, g. It is intended to determine these values with greater accuracy than has hitherto been attained, and at the same time to arrive at a quantitative estimate of the accuracy of these results. Because of the second consideration in particular, any ad hoc restrictions or simplifications are studiously avoided. The procedure is a variational one. The trial state is expanded as a linear combination of basis states chosen in advance. These basis states are carefully chosen to accelerate convergence, and arranged in systematic sequences so that the error from states not included can be estimated. (auth)

34819 MEASUREMENTS OF POLARIZED NEUTRON TRANSMISSION THROUGH MAGNETIZED NICKEL AND COBALT BY A STERN-GERLACH EXPERIMENT. Brand, K.; Nagib, M.; Weber, G. (Institut fuer Reine und Angewandte Kernphysik, Kiel). Atomkernenergie, 11: 283-5 (July-Aug. 1966). (In German).

A previously described Stern-Gerlach experiment producing two neutron beams polarized in opposite directions was used as neutron polarizer. With this experiment transmission measurements were made with magnetized nickel and cobalt. The results are within the experimental errors in good agreement with the values calculated from the theory of Halpern et al. These measurements at different magnetization of the samples give the law of the approach to magnetic saturation at high fields in form of a 1/H-dependence. (auth)

34820 INVESTIGATION ON BLOCH'S DOMAINS IN FERROMAGNETIC COBALT BY POLARIZED NEUTRONS. Nagib, M. N. (Christian-Albrechts Univ., Kiel). Atomkernenergie, 11: 286-94(July-Aug. 1966).

A Stern-Gerlach magnet was used to produce neutron polarization. Using a mechanical velocity selector as a neutron monochromator, two well-separated neutron beams which are oppositely polarized to about 100% could be obtained and the passage of polarized neutrons in polycrystalline cobalt could be studied. The polarization cross section was determined as 1.08 ± 0.04, 0.9 ± 0.07, and 0.84 ± 0.08 barns for 1960, 2220, and 2460 m/sec neutrons velocities respectively, which are in agreement with the theoretically calculated cross-section curve for the hexagonal form of cobalt. The law of approach to magnetic saturation was also investigated with cobalt, and a 1/H

dependence was found for fields ranging from 2,500 to 25,000 gauss in consistence with previously determined results with iron. (auth)

34821 EXCHANGE-COUPLED F-CENTER PAIRS IN MAGNESIUM OXIDE. Henderson, B. (Atomic Energy Research Establishment, Harwell, Eng.). Brit. J. Appl. Phys., 17: 851-4(July 1966).

Exchange-coupled F-center pairs have been observed in neutron-irradiated magnesium oxide by paramagnetic resonance. Studies of the temperature dependence of the signal intensity indicate that the exchange energy J/k = 80 ± 10°K. The measured spin-hamiltonian parameters are consistent with the pair of F centers being in next nearest-neighbor association along the ⟨100⟩ axis, as reported earlier for similar defects in calcium oxide. (auth)

34822 SATURATION OF F-CENTER PRODUCTION IN ALKALI HALIDES UNDER PROTON IRRADIATION. Pooley, D. (Atomic Energy Research Establishment, Harwell, Eng.). Brit. J. Appl. Phys., 17: 855-61(July 1966).

Protons in the energy range 100 to 400 kev have been used to study the saturation of the stage II intrinsic F-center production process in alkali halides. In most cases protons in this energy range have well-defined ranges which are proportional to their energy, being about 1.5 μm in KCl at 100 kev. It is possible, therefore, to produce heavy uniform radiation damage in a very thin layer while keeping the optical density in an accessible region. Stage II F-center production has been found to saturate at an F-center concentration of about 10^{-3} at room temperature, and at a concentration of about 3×10^{-4} at 4°K. Although the protons do combine with F centers to form U centers this does not contribute significantly as a cause of saturation, which seems to be due to the spontaneous recombination of vacancies and interstitials. The protons are channelled along [100] and other symmetry directions and the channelled particles lose energy by electronic excitation at a rate which is smaller than for non-channelled particles. (auth)

34823 MAGNETOSTATIC PROPERTIES OF T_2Co_{17} ALLOYS IN WHICH T IS A METAL OF THE RARE EARTHS OR YTTRIUM. Laforest, Jean; Lemaire, Remy; Pauthenet, Rene; Schweizer, Jacques (CEN, Grenoble, France. Laboratoire d'Electrostatique et Physique du Metal, Grenoble, France). Compt. Rend., Ser. B, 262: 1260-3 (May 9, 1966). (In French).

The magnetic properties of T_2Co_{17} alloys were interpreted by ferrimagnetic coupling of the spin of cobalt atoms with those of rare earth atoms; the order of magnitude of the rare earth–cobalt interaction was determined. The rare earths studied were Y, Ce, Pr, Nd, Sm, Gd, Tb, Dy, Ho, Er, and Tm. (tr-auth)

34824 DISTRIBUTION OF ABSORBED AND STORED RADIATION ENERGY WITH RESPECT TO THE MULTIPLICITY OF LOCALIZATION IN A SOLID BODY. Vaisburd, D. I.; Melik-Gaikazyan, I. Ya. (Kirov Tomsk Polytechnical Inst., USSR). Dokl. Akad. Nauk SSSR, 166: 391-4(Jan. 11, 1966). (In Russian).

The accumulation of F- and M-centers in proton-irradiated single crystals of lithium fluoride was studied. The study was based on the fact that the depth of penetration of protons into the crystal, and therefore the thickness of the color layer, depends on the proton energy. The accumulation of F-centers was studied to concentrations of approximately $5 \cdot 10^{19}$ cm^{-3}. The effectiveness of the F-M reaction decreases with the radiation dose in the region where accumulation of R-centers is insignificant. The effectiveness of this reaction decreases with a reduction in proton energy and shows satisfactory correlation with the depth of proton penetration for a number of alkali halide crystals. It was assumed that overlapping of proton tracks in the crystal is responsible for these effects. The distribution of the irradiated volume with respect to localization multiplicities of absorbed radiation energy was determined. It is shown that the effectiveness of the F → M reaction is higher for crystals in which the volume of the track is greater for irradiation of crystals with various chemical compositions. The track volume is greater for crystals in which the stopping power is lower. This explains the correlation between reaction effectiveness and depth of proton penetration. It was found from the energy accumulated in F-centers, assuming a cylindrical track, that the diameter of a 2.7 Bev proton track is 35 Å. (JPRS)

34825 STUDY OF THE STRUCTURAL TRANSFORMATIONS OF UO_2 UNDER THE INFLUENCE OF HIGH TEMPERATURE AND ADDITIONS OF DIOXIDES OF ZIRCONIUM OR THORIUM. Kuleshov, I. M.; Shishakov, N. A.; Kavtaradze, N. N.; Sokolova, N. P. (Inst. of Physical Chemistry, Academy of Sciences, SSSR). Dokl. Akad. Nauk SSSR, 166: 880-2(Feb. 1, 1966). (In Russian).

The effect of ZrO_2 and ThO_2 admixtures and thermal pretreatment on the properties and structure of uranium dioxide was studied on samples prepared by coprecipitating the hydroxides, reducing to UO_2, grinding into a powder and pressing into pellets, then hardening and quenching. The transformations taking place were observed by chemical and spectral (x-ray and infrared) methods. It is shown that thermal hardening of pressed UO_2 in the presence of small amounts of ZrO_2 or ThO_2 at high temperatures (1600°C) causes an increase in its crystal lattice parameters and changes in the absorption bands in the infrared spectra. These structural changes also substantially affect the vaporization of UO_2. The latter is decreased by the presence of ZrO_2 and ThO_2. (ATD)

34826 ELECTRON CONDUCTION AND BREAKDOWN IN KCl CRYSTALS IRRADIATED BY GAMMA RAY. Inuishi, Yoshio; Sung, Yung-Kwon (Osaka Univ.). Electrotech. J. Jap., 8: 143-6(1963).

Pulse F band photoconduction up to prebreakdown range and the dielectric breakdown field of KCl crystals irradiated by ^{60}Co γ rays were investigated. Single KCl crystals were prepared and furnished with a vacuum evaporated gold electrode at one side of the sample (conduction sample) or at both sides (breakdown sample). These samples were then irradiated at room temperature to introduce lattice defects at a dose rate of 3×10^5 R/hr. From the saturation of pulse photocurrent with respect to electric field, the product of the mobility and the lifetime ($\mu\tau$) and the relative value of quantum yield for photoconduction (η) were obtained at various temperatures and F center densities. Apparently, for a longer pulse the value of η increases above about −60°C with increasing temperature, whereas the value of $\mu\tau$ decreases. The current multiplication, which may be due to impact ionization of F center, was found only just below the breakdown field. The temperature dependence of the breakdown field is discussed. Illumination with F-band light during the d-c breakdown lowered the breakdown field markedly. This phenomenon is probably due to the cathodic field enhancement through the formation of the positive space charge caused by the photoionized F center. (BBB)

34827 ENERGY AND CHARGE TRANSFER OVER HYDROGEN BRIDGES. Riehl, N. (Technische Hochschule, Munich). pp 95-104 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

The role of the hydrogen protonic bridge in energy transfer in crystals is investigated for the case of ice. Rotational and translational jumps of protons are described. The measurement of the dielectric constant of ice and the self-diffusion constant for the proton in ice are examined in detail, and their values are related to the proton mobility. The behavior of ice cooled to 77°K and of other organic and inorganic systems which can serve as models for the phenomenon of protonic transfer are briefly considered. (B.L.M.)

34828 THERMOLUMINESCENCE OF INORGANIC AND ORGANIC MATERIALS. Thomas, B.; Isaac, G. (Welsh Coll. of Advanced Tech., Cardiff, Wales). pp 105-13 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966.

Measurements resulting from the successful application of thermoluminescence to the study of MgO were extended to include studies of defects and irradiation processes in polymer material. Samples of MgO, doped MgO crystals, polyethylene terephthalate were irradiated with x and uv radiation, and the thermoluminescence curves were recorded. The doping was found to quench the thermoluminescence of the MgO. Thermal activation energies were proposed for some of the recorded peaks, and attempts were made to relate them to optical activation energies using an optical bleaching technique. An optical model for MgO is proposed. (B.L.M.)

34829 INFLUENCE OF γ RADIATION AND FAST NEUTRONS ON THE ELECTROPHYSICAL PROPERTIES OF SINGLE CRYSTALS OF CADMIUM SULFIDE. Galushka, A. P.; Ermolovich, I. B.; Korsunskaya, N. E.; Konozenko, I. D.; Sheinkman, M. K. (Inst. of Physics, Kiev). Fiz. Tverd. Tela, 8: 1040-8(Apr. 1966). (In Russian).

The log conductivity of single CdS crystals varies almost linearly with the log fast neutron current between 10^{15} n/cm^2 (10^{-6} ohm^{-1} cm^{-1}) and 10^{17} n/cm^2 (10^{-6} ohm^{-1} cm^{-1}). The spectral distribution for photoconductivity of CdS monocrystals upon irradiation with fast neutrons shows an increase in the conductivity of the long-wavelength region; after irradiation with 5×10^{15} n/cm^2 a maximum appears at 650 mμ. and after 2.2×10^{17} n/cm^2 this has decreased in magnitude. The temperature dependence of the mobility of electrons in CdS retains the usual general shape on irradiation, but low-temperature values are greatly decreased: an unirradiated sample had $\mu = 2000$ cm^2/v sec; for 2.2×10^{17} n/cm^2 irradiations this dropped to 100 cm^2/v sec, and for γ rays (1.06×10^{19} kv/cm^2), to 200 cm^2/v sec, all at 100°K; at 300°K the respective values were 300, 80, and 70. The luminescence spectrum at 77°K was not greatly altered by irradiation with 1.06×10^{19} kv/cm^2 γ rays, but after irradiation with 2.2×10^{17} n/cm^2, new maxima appeared at 590 and 1030 mμ. The photoconductivity is reduced by γ radiation by a factor of more than 10, and the intensity of the absorption at 1400 mμ in the ir spectrum is also increased. (BBB)

34830 ROLE OF PARTICLE CHANNELING IN DETECTOR SYSTEMS. Gibson, W. M. (Bell Telephone Labs., Inc., Murray Hill, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 162-75(June 1966).

The status of channeling studies is summarized, and the effects of channeling on scattering and energy-loss measurements are discussed. (D.C.W.)

34831 GROWTH AND IMPURITY EFFECTS ON FLUORESCENCE AND REDUCTION OF CaF_2:Sm^{3+}, Y^{3+}. Ewanizky, T. F.; Theissing, H. H. (Army Electronics Command, Fort Monmouth, N. J.). J. Chem. Phys., 45: 79-81(July 1, 1966).

Observations are made of the effects of annealing and Y, O, or Na impurities on the growth and reduction of various types of Sm centers in CaF_2. Increase of Sm^{3+} fluorescence with increase of annealing time is believed to be indicative of axial center formation. Radiation-induced reduction of Sm^{3+} centers in cubic, tetragonal, or trigonal crystalline fields is studied. The absorption spectra after irradiation are shown to be dependent on the original symmetry of the field surrounding the trivalent ions. (auth)

34832 MOESSBUAER EFFECT IN ANTIFERROMAGNETIC FINE PARTICLES. Shinjo, Teruya (Kyoto Univ.). J. Phys. Soc. Jap., 21: 917-22(May 1966).

Mössbauer measurements were made on fine particles of antiferromagnetic α-FeOOH, with various particle sizes, to examine the Mössbauer spectra in fluctuating fields produced by the relaxation of electron spins. In ultra fine samples, the collapse of the internal field due to superparamagnetism was observed. The critical volume at 294°K was found to be 3×10^{-17} cm^3 and the critical temperature for the sample of 1×10^{-17} cm^3 to be 210°K. The effective anisotropy constant was estimated to be of the order of 10^4 erg/cm^3. The transitional patterns from the ordinary magnetic splitting (6-line) to the superparamagnetic doublet are discussed, and the assignment of the doublet is attempted in comparison with Blume's prediction. (auth)

34833 ELECTRON DIFFRACTION BY FLUX LINES. Yoshioka, Hide (Nagoya Univ., Japan). J. Phys. Soc. Jap., 21: 948-54(May 1966).

A theory of electron diffraction at magnetic flux lines is presented. For a flux line with an infinitesimal radius, a good approximation to Aharonov and Bohm's results is obtained by the use of Kirchhoff's diffraction theory. Then, diffraction in a crystal having a flux line with a finite radius is treated by the method of eikonal functions similar to that used in Kato's diffraction theory for imperfect crystals. The possibilities of observing flux lines in type-II superconductors are discussed. (auth)

34834 F AGGREGATION OF REACTOR-IRRADIATED NaCl CRYSTALS. Ikeda, Masaomi; Nishi, Masato; Ryu, Norio (Hiroshima Univ.). J. Phys. Soc. Jap., 21: 1014 (May 1966).

The optical absorption spectra of reactor-irradiated NaCl crystals that had been previously colored up to a stable secondary stage with ^{60}Co gamma rays at room temperature were investigated. It was found that under prolonged neutron irradiation (24-hr period), the F and the R bands exhibit a remarkable growth. (G.O.Y.)

34835 INVESTIGATION OF CRYSTAL DYNAMICS BY MEANS OF THERMAL NEUTRON SCATTERING. Solt, Gyoergy (Central Physical Research Inst., Budapest). Magyar Fiz. Foly., 14: 89-141(1966). (In Hungarian).

The theory of the structure of crystals, developed by Born and von Karman, expressed in terms of quantum mechanics was found to be very fruitful in explaining the physical properties of crystals. The crystal is considered as a giant molecule with a periodically recurrent structure; the ions constituting the lattice oscillate with a low amplitude about the points of equilibrium. The energy, polarization and other physical properties depend on the chemical bond. The theory could be verified experimentally only since thermal neutron beams from reactors became available. By means of the incident beam on the crystal, the dynamic properties of the lattice atoms may be determined. The experimental and theoretical simplicity rendered neutron scattering the foremost research tool in this field. The basic principles of crystal physics are reviewed, examining also the neutron-photon interactions. The physical properties of the crystal's nuclei made possible the coherent neutron scattering, allowing the determination of the related dispersion correlations and polarization measurements in the Brillouin zone. Neutron scattering experiments on a large number of materials yielded valuable dynamic data on the crystal phonons. The Born-Karman model was found useful in some cases, e.g., for Na, but was not applicable in others, such as Ge and Pb. The deviations are probably due to the strong interaction between phonons and conductivity electrons. This so-called Kohn effect makes it possible to investigate electron dynamic Fermi surfaces in metals with strong interaction. The phonon-phonon and electron-phonon interactions also affect the scattering phenomena. (TTT)

34836 OPTICAL PROPERTIES OF F CENTERS IN POTASSIUM CHLORIDE CRYSTALS IRRADIATED IN A REACTOR. Davitashvili, T. Sh.; Politov, N. G. Opt. Spectros. (USSR) (Engl. Transl.), 20: 146-8(Feb. 1966).

Translated from Opt. Spektros., 20: 272-5(Feb. 1966).

The theory developed for F centers with ideal surroundings can be applied to F centers in a deformed environment if the parameters of the F band optical absorption are changed. An attempt is made to compare these changes with those which follow from the configuration curve and to examine the optical properties of F centers in a deformed environment such as neutron irradiated KCl crystals. (B.G.D.)

34837 ABSORPTION SPECTRUM OF NEUTRON-IRRADIATED SILICON IN THE NEAR INFRARED. Kiril-

lova, V. M.; Lotkova, E. N. Opt. Spectros. (USSR) (Engl. Transl.), 20: 181-2(Feb. 1966).
Translated from Opt. Spektros., 20: 337-9(Feb. 1966).
A study is presented concerned with the infrared absorption in the 0.7−1.7 μ range by silicon single crystals irradiated with fast neutrons in doses of $10^{17}-10^{18} n_0/cm^2$. (B.G.D.)

34838 OBSERVATION OF AN UNSTABLE N BAND IN NaF. Andrews, R. A.; Kim, Y. W. (Wayne State Univ., Detroit). Contract AT(11-1)-1054. Phys. Lett., 21: 616-17(July 1, 1966).
Experimental evidence is presented of an unstable N-band in x-irradiated NaF. The observed behavior of the F- and M-bands, and the band N during optical bleaching is illustrated. The λ_{max} of the band N is found to be fairly close to that predicted by the Ivey relation for the N_2-band of KCl and other halides. (L.B.S.)

34839 CRYSTAL AND MAGNETIC STRUCTURES OF CeC_2, PrC_2, AND NdC_2. Atoji, M. (Argonne National Lab., Ill.). Phys. Lett., 22: 21-2(July 15, 1966).
Neutron diffraction study has revealed that CeC_2, PrC_2, and NdC_2 become a body-centered first-kind antiferromagnet below 33, 15, and 29° with the ordered moments having 81, 44, and 90% of the free-ion values, respectively. The moment direction is parallel to the tetragonal c axis. (auth)

34840 THEORY OF MAGNETIZATION OF TmSb, TmAs, TmP WITH SINGLET GROUND STATE. Cooper, B. R. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Lett., 22: 24-5(July 15, 1966).
Calculations are presented which show that the susceptibility and high field magnetization curves of TmSb, TmAs, and TmP can be understood on the basis of predominant crystal field effects. (auth)

34841 OBSERVATION OF THE R_N BAND IN LiF NEAR 300°K. Van Der Lugt, K.; Kim, Y. W. (Wayne State Univ., Detroit). Contract AT(11-1)-1054. Phys. Lett., 22: 50-1 (July 15, 1966).
Thermal annealing and optical bleaching of samples of neutron- or gamma-irradiated single crystals of LiF yielded evidence of a broad band near 300°K, which is similar to the R_N band of KCl. (L.B.S.)

34842 MOESSBAUER EFFECT IN SOLID KRYPTON. Pasternak, M.; Simopoulos, A.; Bukshpan, S.; Sonnino, T. (Israel Atomic Energy Commission, Yavne). Phys. Lett., 22: 52-3(July 15, 1966).
The Mössbauer effect of the 9.3 kev transition in ^{83}Kr was observed with a solid krypton absorber and krypton-hydroquinone clathrate source. The linewidth broadening of the source is studied. A θ_D of 37°K for solid krypton is derived from the temperature dependence of the area of the peak. (auth)

34843 ZERO-BIAS ANOMALIES IN NORMAL METAL TUNNEL JUNCTIONS. Rowell, J. M.; Shen, L. Y. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett., 17: 15-19(July 4, 1966).
The current flow through thin chromium-oxide layers from 1 to 290°K is investigated. It is believed that current flows by means of a tunneling mechanism, but the dependence of the dynamic resistance of the junction on voltage and temperature is completely anomalous in terms of expected tunneling behavior. Some new results on other metal-oxide junctions strongly suggest that properties of the oxide layer are responsible for the anomaly observed by Wyatt in tantalum oxide junctions. (auth)

34844 OBSERVATION OF NEW MOESSBAUER EFFECTS IN RARE-EARTH ISOTOPES FOLLOWING COULOMB EXCITATION. Eck, J.; Lee, Y. K.; Ritter, E. T.; Stevens, R. R. Jr.; Walker, J. C. (Johns Hopkins Univ., Baltimore). Phys. Rev. Lett., 17: 120-2(July 18, 1966).
Observations are reported of Mössbauer effects in the decay of nuclear levels in ^{160}Gd, ^{164}Dy, ^{168}Er, and ^{174}Yb, in an attempt to determine which families of isotopes are most suitable for detailed study because of large effects and well-resolved hyperfine structure. In addition to providing preliminary estimates of nuclear moments, indications of distortion of Mössbauer hyperfine spectra which can be attributed to radiation damage effects in the target are presented. (B.G.D.)

34845 CRYSTAL BINDING EFFECT OF THE MULTIPLE SCATTERING OF HIGH-ENERGY CHARGED PARTICLES. DeWames, R. E.; Hall, W. F. (North American Aviation, Inc., Thousand Oaks, Calif.). Phys. Rev. Lett., 17: 122-5(July 18, 1966).
The crystal binding effect on the angular distribution of particles which have suffered single or multiple scattering with the lattice atoms is discussed. Suggestions are made of experiments to observe the predicted dependence. (B.G.D.)

34846 NUCLEAR POLARIZATION BY HOT CARRIER FLOW IN SEMICONDUCTORS. Kalashnikov, V. P. (Inst. of Metal Physics, Sverdlovsk, USSR). Phys. Status Solidi, 15: 473-85(June 1, 1966).
The nuclear polarization resulting from the interaction of the nuclei with a non-equilibrium, steady-state, distribution of hot conduction electrons generated by crossed static magnetic and strong electric fields is investigated theoretically. The effect of a strong electric field on the spin-lattice relaxation times of the conduction electrons and the relaxation time of the nuclei by hyperfine interaction with hot carriers are considered for various types of semiconductors. Formulas for the field-enhanced nuclear magnetization, and for the relaxation times of the electronic and nuclear magnetic moments, are obtained as functions of the current density of the conduction electrons. (auth)

34847 DETECTION OF FRENKEL DEFECTS IN X-IRRADIATED LiF. Balzer, R.; Peisl, H.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Phys. Status Solidi, 15: 495-500(June 1, 1966). (In German).
LiF crystals are irradiated with x rays at room temperature and the color centers formed are detected by optical absorption measurements. The distortion of the crystal lattice by point defects is studied from the relative lattice parameter and macroscopic density change of the irradiated crystals. It is concluded that Frenkel defects are created during x irradiation. (auth)

34848 TRANSITION RADIATION FROM THREE-LAYERED FOILS. Steinmann, W.; Wille, H. (Univ., Munich). Phys. Status Solidi, 15: 507-14(June 1, 1966).
A general expression is derived for the transition radiation from a foil consisting of three different layers with arbitrary dielectric constants and thicknesses. This expression is used to calculate transition radiation from oxide-covered Al foils. The results are compared with the experimental data of Herickhoff et al. Almost perfect agreement between theory and experiment can be achieved if the oxide layers are taken into account. (auth)

34849 ANTIFERROMAGNETIC STRUCTURE OF URANIUM DIPHOSPHIDE. Troc, R.; Leciejewicz, J.; Ciszewski, R. (Wroclaw Technical Univ. Inst. of Nuclear Research, Swierk, Poland. Warsaw Technical Univ.). Phys. Status Solidi, 15: 515-19(June 1, 1966).
The antiferromagnetic structure of tetragonal UP_2 below the Néel temperature (203°K) is determined by neutron diffraction with polycrystalline samples. The magnetic unit cell is twice the size of the chemical one along the c-axis. The magnetic structure consists of ferromagnetic sheets of uranium stacked along the c-axis in the order +− −+. The magnetic moments of the uranium are parallel to the c-axis; their magnitude is (1.0 ± 0.1) BM. (auth)

34850 ENERGY LOSSES OF FAST ELECTRONS IN ALKALI HALIDE FILMS AND THEIR ANGULAR DEPENDENCE. Geiger, J.; Odelga, P.; Pfeiffer, H.-Chr. (Technische Univ., Berlin). Phys. Status Solidi, 15: 531-7(June 1, 1966). (In German).
The energy loss spectra of fast electrons passing through

thin alkali halide films are measured. One peak in each spectrum corresponds to the excitation energy of plasma vibrations which can be calculated formally by assuming the valence electrons to be free. The experimental dispersion relation shows that, to within experimental error, the magnitude of the energy losses is independent of the scattering angle. This does not agree with measurements reported by Sueoka. Therefore these energy losses cannot be explained by the excitation of free electrons. The intensity of the energy losses decreases with increasing scattering angle approximately as ϑ^{-2}. (auth)

34851 ANGULAR DEPENDENCE OF SPUTTERING AND KINETIC ELECTRON EMISSION OF SINGLE CRYSTALS. Martynenko, Yu. V. (Kurchatov Inst. of Atomic Energy, Moscow). Phys. Status Solidi, 15: 767-76(June 1, 1966).

The dependence of the sputtering yield K on the angle of incidence ψ is calculated for single crystals by taking into account multiple collisions of the ions with atoms of the crystal. The secondary collisions increase the maxima of the curve $K(\psi)$ but do not alter the form of the minima. The effect of lattice defects on the function $K(\psi)$ is also considered. These defects mainly alter the minima in $K(\psi)$ and on the whole decrease the anisotropy of the sputtering yield. Electron emission from single crystals due to ion bombardment is treated in a similar way assuming a kinetic emission mechanism. (auth)

34852 EXCITON ROTATORY DISPERSION OF SODIUM URANYL ACETATE SINGLE CRYSTALS AT LOW TEMPERATURES. Dovgii, Ya. O. (Lvov State Univ.). Phys. Status Solidi, 15: K77-81(June 1, 1966).

The rotary dispersion of optically active sodium uranyl acetate single crystals at low temperatures in the region of exciton absorption is investigated by a method based on photographic photometry. (B.G.D.)

34853 COTTON EFFECT FOR CIRCULAR EXCITONS. Dovgii, Ya. O. (Lvov State Univ.). Phys. Status Solidi, 15: K99-103(June 1, 1966).

Optically active sodium uranyl acetate crystals display a strong circular dichroism (Cotton effect) in the region of exciton absorption. The temperature dependence of this phenomenon in the region of the ϵ-band $\nu_m^{20°K} = 21135\ cm^{-1}$ is investigated. (B.G.D.)

34854 ZERO-PHONON TRANSITIONS AT M' AND R' CENTERS IN ALKALI HALIDES. Fitchen, D. B. (Cornell Univ., Ithaca, N. Y.); Fetterman, H. R.; Pierce, C. B. Solid State Commun., 4: 205-9(May 1966). (NYO-3464-1).

Infrared zero-phonon lines observed in the optical spectra of five irradiated alkali halides are identified with M' and R' centers. Uniaxial-stress spectra for LiF and KCl indicate rhombic and trigonal symmetry respectively. The formation and bleaching behavior and spectral positions are consistent with prime centers. Resonance lines and mirror bands are seen in emission for both centers in LiF. (auth)

34855 DEPENDENCE OF THE ROOM TEMPERATURE F-CENTER COLORATION ON THE IRRADIATION DOSE SEQUENCE. Agullo-Lopez, F. (Junta de Energia Nuclear, Madrid). Solid State Commun., 4: 275-7(June 1966).

The room temperature F-center coloration of NaCl with γ-rays was found to depend sensitively on the sequence of irradiation doses, for relatively high radiation intensities. For low enough intensities, the effect can be made practically unobservable. (auth)

34856 NEUTRON STUDY OF THE DIFFUSION OF HYDROGEN IN PALLADIUM. Skoeld, K.; Nelin, G. (Aktiebolaget Atomenergi, Studsvik, Sweden). Solid State Commun., 4: 303-6(June 1966).

The diffusion of hydrogen in α-phase Pd-H was studied by inelastic neutron scattering. Data are in good agreement with predictions by the jump-diffusion model. The value obtained for the jump length implies that the hydrogen atoms occupy octahedral interstitial sites. The observed variation of the residence time with temperature yields the value (3700 ± 500) cal/g-atom for the activation energy. (auth)

34857 MOESSBAUER EFFECT OF THE 14.4-kev γ LINE OF ^{57}Fe IN THE SUPERPARAMAGNETIC FERRITES OF PORTLAND CEMENT. Pobell, Frank (Bayerische Akademie der Wissenschaften, Munich); Wittmann, Folker. Z. Angew. Phys., 20: 488-92(1966). (In German).

The Moessbauer spectra of pure portland cement, of portland cement enriched with calcium aluminum ferrite, and of pure calcium aluminum ferrite were measured at different temperatures. The results confirm that iron is bound in portland cement mainly in 4 $CaO \cdot Al_2O_3 \cdot Fe_2O_3$. When calcium aluminum ferrite is sintered with portland cement, the crystal structure of the ferrite remains unchanged. The Moessbauer spectra of ^{57}Fe of the ferrite present in portland cement can be understood, assuming that the volumes of some of the ferrite particles are small enough to show superparamagnetism. By increasing the concentration of the ferrite in the portland cement and by lowering the temperature of the sample, we were able to observe the transition of some of the ferrite from superparamagnetic to ferrimagnetic behavior. (auth)

34858 DETERMINATION OF CRYSTALLITE SIZE DISTRIBUTION FROM X-RAY LINE BROADENING. Hossfeld, Friedel; Oel, Heribert J. (Max-Planck-Institut fuer Silikatforschung, Wuerzburg, Ger.). Z. Angew. Phys., 20: 493-8(1966). (In German).

A new procedure for determination of crystallite size distribution based on the broadening of x-ray diffraction peaks, was developed and applied to (sintered) powder specimens of MgO and ThO_2. (auth)

34859 M-CENTER FORMATION IN X-RAY-IRRADIATED KCl. Horn, G.; Peisl, H. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 194: 219-23(1966). (In German).

The equilibrium between F- and M-center concentration in KCl after x irradiation at temperatures between 77°K and 298°K was studied. At low temperatures (<200°K) only F-centers which are formed statistically as nearest neighbors give an M-center. At higher temperatures F-centers within a certain sphere of interaction with a radius r form M-centers. The temperature dependence of this radius r was evaluated. The equilibrium constant K depends on the temperature in the form $K = K_0 \exp(-Q/kT)$. The activation energy was determined to be $Q = (0.5 \pm 0.1)$ ev. (auth)

34860 DESTRUCTION OF TRANSPARENT DIELECTRICS UNDER THE ACTION OF POWERFUL LASER RADIATION. Ashkinadze, B. M.; Vladimirov, V. I.; Likhachev, V. A.; Ryvkin, S. M.; Salmanov, V. M.; Yaroshetskii, I. D. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 50: 1187-1201(May 1966). (In Russian).

The destruction of a number of transparent dielectrics under the action of a powerful laser radiation is investigated. The nature of the destruction elicited by ordinary as well as gigantic pulses is described. The dependences of the size of the destruction region on energy, position of the focus, lens focus length and temperature are investigated. It is shown that the most consistent mechanism for explaining the destruction is one based on destruction by coherent hypersound phonons produced in a stimulated Mandelstam-Brillouin process. (auth)

34861 QUADRUPOLE INTERACTIONS AND ANISOTROPY OF THE MOESSBAUER EFFECT OBSERVED DURING RESONANCE SCATTERING OF γ QUANTA ON POLYCRYSTALS. Komissarova, B. A.; Sorokin, A. A.; Shpinel, V. S. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 50: 1205-17(May 1966). (In Russian).

The magnitude of quadrupole interaction of ^{119}Sn nuclei in the lattice of white tin is determined by studying the attenuation of the angular distribution of Moessbauer scattering. The values obtained are $E_Q/\Gamma = 0.58 \pm 0.20$, $\Delta = 0.18 \pm 0.6$ mm/sec at 300°K and $E_Q/\Gamma = 0.82 \pm 0.15$, $\Delta = 0.25 \pm 0.05$ mm/sec at 80°K. Here Γ is the width of the nuclear level and Δ is the hyperfine splitting. The influence of anisotropy of the Moessbauer effect in crystals of the angular distributions of resonance scattering corresponding to excitation of individual components of the allowed quadrupole doublet is considered theoretically. It is

shown that even when the measurements are carried out on polycrystalline samples it is possible in principle to derive from angular distribution functions both the magnitude and sign of anisotropy of the effect and the sign of the quadrupole interaction. Experimentally, the influence of the Moessbauer effect has been detected in measurements of the angular distributions for the quadrupole doublet components in the compound $(C_4H_9)_2SnO$. (auth)

34862 ATTENUATION OSCILLATIONS AND THE VELOCITY OF SOUND WAVES IN SEMICONDUCTORS AND METALS IN THE PRESENCE OF A STRONG MAGNETIC FIELD. Pustovoit, V. I.; Poluektov, I. A. Zh. Eksp. Teor. Fiz., 50: 1265-78(May 1966). (In Russian).

It is shown that an important factor in the establishment of the amplitude of the attenuation oscillations of ultrasound waves in degenerate semiconductors and metals is the formation of a volume charge by the wave and of a Coulomb field connected with it. This circumstance is taken into account in setting up a dispersion equation for propagation of ultrasound waves in semiconductors and metals. It can be seen from the equation that in order to investigate the nature of the oscillations a knowledge of the complex longitudinal conductivity of the medium is required. In order to find the complex permittivity of the medium under conditions of Landau quantization, the equation for the density matrix operator is considered. It is shown that for calculation of the longitudinal permittivity of the medium the equation for the density matrix in which collisions are taken into account can be reduced to the "kinetic equation" for a single matrix element. The possibility of oscillation of the imaginary and real parts of the conductivity is considered. It is shown that the imaginary part of the conductivity oscillates only under some very rigorous conditions. Attenuation and sound velocity oscillations connected with oscillations of the real part of the conductivity are considered. The results are compared with the experiments. (auth)

34863 DYNAMICAL THEORY OF X-RAY INTERFERENCE WITH THE DURATION OF COHERENT RADIATION TAKEN INTO ACCOUNT. Bezirganyan, P. A. (Erevan State Univ.). Zh. Tekh. Fiz., 36: 515-20(Mar. 1966). (In Russian).

The early calculation of C. G. Darwin of the diffraction of x rays from an infinitely thick ideal crystal, taking into account the finite coherence time of the beam is repeated. It is also found that Darwin's conclusion that the forward-scattered and reflected waves from a single lattice plane differ in phase by 90° violates energy conservation and, accordingly, corrects this shortcoming of the early calculations. Owing to the finite length of the coherent wave train, only a finite number of lattice planes contribute to formation of the interference pattern at any instant and the expression for the scattered intensity involves a finite sum. This summation is performed and the final formula is thereby somewhat simplified, although it still remains rather involved. It is found that the maximum intensity of the reflected beam does not occur at the Bragg angle; a formula is given for the difference between the Bragg angle and the true angle for maximum reflected intensity. The maximum reflection coefficient is less than unity. It is estimated that the maximum coefficient for reflection of Mo $K\alpha_1$ radiation by the (211) planes of a thick ideal calcite crystal is 0.62. This estimate is based on the value 2.4×10^{-16} sec for the coherence time of the radiation, which was calculated with the formula $A\lambda^2$ where λ is the wavelength and $A = 4.7$ sec/cm^2. (ATD)

34864 METODY KVANTOVOI TEORII MAGNETIZMA. (Methods of Quantum Theory of Magnetism). Tyablikov, S. V. Moscow, Izdatel'stvo Nauka, 1965. 334p.

Methods for the theoretical study of the magnetic properties of matter on the basis of quantum statistical physics are considered. A short summary of background data from the physics of magnetism and statistical mechanics is given. Explanations are presented of the approximate second quantization method and spin waves, the molecular field and perturbation theory, the Green's function method, and the ferromagnetic and antiferromagnetic materials and ferrites. The methods presented are applicable also to other problems in solid-state physics. (M.J.T.)

34865 ULTRASONIC EXCITATION OF NUCLEAR SPIN RESONANCE IN SINGLE-CRYSTAL METALLIC TANTALUM. Gregory, Eugene Herbert. Los Angeles, Univ. of California, 1966. 113p.

Thesis.

The direct ultrasonic technique was used to observe the nuclear spin resonance of ^{181}Ta in bulk single crystals of metallic tantalum. This represents the first unambiguous observation of an ultrasonically induced nuclear spin resonance in a metal. The advantages of the ultrasonic method over conventional nuclear resonance techniques for work in single-crystal metals are obvious in that one is not hampered by electrical skin depth problems. In contrast to r-f electromagnetic radiation, the acoustic waves are capable of penetrating into the bulk of the metal sample. The interaction between the nuclear spin and the ultrasonic wave is via the torque exerted on the nuclear electric quadrupole moment by the dynamic electric field gradient created by the passage of the wave. The ^{181}Ta nuclear spin resonance was observed at temperatures of 77°K and 4.2°K. Transitions were detected where $\Delta m = \pm 1$ and also $\Delta m = \pm 2$, m being the magnetic quantum number of the nucleus. A study of the angular dependence of the resonance intensity was conducted, as well as the effects of sample purity. A model, based on static quadrupole broadening, is proposed to explain the observed line shape. (Dissertation Abstr.)

34866 NUCLEAR MAGNETIC RESONANCE SPIN-LATTICE RELAXATION IN HIGH AND LOW FIELDS. Johnson, Barent Charles. University Park, Pa., Pennsylvania State Univ., 1965. 85p.

Thesis.

An experimental and theoretical study of the magnetic field dependence of nuclear magnetic resonance (nmr) spin-lattice relaxation in solids is reported. Theoretically, density matrix methods and the spin-temperature assumption are used to derive an expression for the relaxation time and to calculate its dependence upon magnetic field. The calculation is kept general by restricting the form of the spin-lattice interaction hamiltonian as little as possible. As an example of this general study, the special problem of relaxation in a quadrupolar solid is solved. A quadrupolar solid is defined as one in which the nuclei transmit their energy to the lattice by the interaction of a time-varying field gradient with the nuclear quadrupole moment. The fluctuating field gradient is produced by the motion of the ions in the lattice. The experimental work described consists of the measurement of the magnetic field dependence of the spin-lattice relaxation time of the Na nuclei in NaCl in both the laboratory and rotating reference frames. This crystal was chosen for study because both nuclear species are believed to relax by the quadrupolar mechanism at high fields. Strong evidence is found that the nuclei in NaCl do not relax by the quadrupolar mechanism in external fields that are small compared to the line width in the solid. (Dissertation Abstr.)

34867 CONCENTRATION EFFECTS AND OSCILLATOR STRENGTHS IN $PrCl_3$. Dorman, Ed Smith. Baltimore, Johns Hopkins Univ., 1965. 120p.

Thesis.

The absorption and fluorescence spectra of Pr^{3+} in $LaCl_3$ were obtained for concentrations of 0.25%, 2%, 15%, 50%, 85%, 100%, and for Pr^{3+} present as a trace impurity in 99.999% pure $LaCl_3$. They were used to determine the effect of concentration on the energy levels and transitions of the ion. A mechanism is advanced to explain the concentration broadening of spectral lines in crystals as due to heterogeneity of the lattice and resonance interaction between the spectroscopically active ions. Oscillator strengths were measured for transitions in the visible region of the Pr^{3+} absorption spectrum. The ion-pair absorption spectrum was obtained, and the intensities of its lines were measured. (Dissertation Abstr.)

34868 TRANSIENT NUCLEAR MAGNETIC INDUCTION IN SOLID H_2–D_2 MIXTURES. Metzger, Daniel Schaffer. Columbus, Ohio, Ohio State Univ., 1965. 130p.

Thesis.

Conventional NMR pulse techniques are applied to study the hydrogen resonance at 9.3 Mc in solid H_2-D_2 mixtures at temperatures of 4.2°K and 1.1°K. In addition to observation of the free induction signal following a single 90° pulse (Bloch decay), spin echoes that can be seen for times long compared with the time required for the Bloch decay to vanish are observed to follow a $90°-\tau-\beta$ pulse sequence, with τ being the time between pulses and β the rotation of the second pulse. The echoes occur at time $t = 2\tau$ and usually exhibit maximum amplitude for β much less than 180°, the classical vector model result. The decay of the echoes as a function of 2τ is very nearly exponential, and the associated time constant, T_E, is dependent on the rotation β such that T_E increases as β decreases. It is shown that as a result of the latter effect the spin echoes have maximum amplitude for $\beta = 90°$ when τ is short; when τ is long, maximum echo amplitude occurs for $\beta < 90°$. At 4.2°K the Bloch decay for nH_2 exhibits an oscillatory behavior that resembles in appearance the beat structure observed in CaF_2 by Lowe and Norberg. In the mixtures the beat structure is not observed for 25% and lower H_2 concentrations; for these concentrations the Bloch decay is essentially gaussian. At 1.1°K the splitting of the resonance line associated with the λ-anomaly is seen as a distinct beat pattern on the Bloch decay. For the mixtures no λ-splitting is observed; instead the Bloch decay shows a narrow central region and a broad tail. The central region is not much affected by changes in H_2 concentration while the tail becomes more broad with decreasing H_2 concentration. The essential features of the Bloch decays and spin echoes are adequately described in terms of a single particle model similar to that used by Solomon for the "multiple echoes" in KI. On the basis of this model, it is shown that under certain conditions the spin echo is an image of the Bloch decay. Analysis of the Bloch decay or echo shapes then gives information regarding the forms taken by the distribution functions $g(\Delta\omega)$ and $f(\alpha)$. Spin-lattice relaxation times, T_1, are measured by a method utilizing repetitive 90° pulses. It is shown that T_1 decreases as the splitting described by the parameter α increases. (Dissertation Abstr.)

34869 IDENTIFICATION AND STUDY BY ELECTRON SPIN RESONANCE OF F_2^- IONS TRAPPED IN ELECTRON-IRRADIATED POTASSIUM BIFLUORIDE. Otto, Fred Bishop. Storrs, Conn., Univ. of Connecticut, 1965. 118p.

Thesis.

An ESR spectrum attributed to F_2^- molecular ions trapped at anion sites was observed after electron bombardment of single crystals of KHF_2 at 77°K. A total of eight lines was observed in the ESR spectrum resulting from hyperfine splitting associated with two inequivalent sites. The angular variation of each four-line spectrum showed axial symmetry and varied from 1910 G along the z axis of the site to 3 G perpendicular to it. The spectrum and its angular variation correspond to a single electron vacancy shared by two nuclei of spin ½ strongly coupled to the molecular axis giving an effective spin of 0 or 1 and a very anisotropic A tensor. The effective nuclear spin 0 gives rise to a single-line spectrum, which coincides at nearly all angles with the center line of the three-line spectrum resulting from a nuclear spin 1, causing the spectrum to appear as a three-line spectrum with an intensity ratio 1:2:1. It was found that the angular variation could be described in detail by numerical diagonalization of the spin energy matrix. At 77°K the values of the g tensor were determined to be $g_{\|} = 2.0020 \pm 0.001$ and $g_{\perp} = 2.0168 \pm 0.001$ and the values of the A tensor were $A_{\|} = 955.4 \pm 1$ G and $A_{\perp} = 21 \pm 4$ G. The values of the g and A tensors were also measured at 300°K as $g_{\|} = 2.0024 \pm 0.001$, $g_{\perp} = 2.0180 \pm 0.0015$, $A_z = 928.8 \pm 1$ G, $A_x = 35.5 \pm 1$ G, and $A_y = 25.5 \pm 3$ G. The irradiated crystals, which had changed from clear to bright green in appearance, were found to have optical absorption bands at 2.0 and 4.1 ev immediately after warming to 300°K. The 2.0-ev optical band annealed rapidly at 300°K; however, the 4.1-ev optical band, after an initial rapid anneal, annealed by a factor of two about every 10 hr corresponding closely to the observed ESR annealing behavior. (Dissertation Abstr.)

REACTOR TECHNOLOGY

General

Refer also to abstracts 33466, 33469, 33800, 33807, 33808, and 34160.

34870 (EUR-2984.e) COLLECTION AND ANALYSIS OF DATA ON THE LIFE-EXPECTANCY OF ORGANIC PLANT COMPONENTS. Capobianchi, S.; Rougeau, J. P.; Volta, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 1966. 24p. Dep. mn.

A preliminary scheme is outlined for collecting and automatically handling operating data of organic reactor loop components. This scheme can be applied to other types of components as well. In the collection step, each plant is subdivided into "loops" and each loop into components. All of the loops and components constitute an inventory which is stored at the computation center and updated with the same frequency as the collection of the operating data. Operating data of each loop are automatically attributed to its components unless particular conditions for a given component are specified. Four groups of information are foreseen in the statistical analysis. These groups are respectively concerned with the components in the inventory, the loop operating data, the operating data of components classified by nature and type and the failure rate of the latter. (auth)

34871 UTILIZATION OF FUEL RESOURCES IN DIFFERENT REACTOR TYPES. Marien, P. Nucl. Eng., 11: 543-5(July 1966).

Fuel utilization is discussed adopting more general definitions of burnup and rating and introducing a utilization factor that combines fuel consumption and investment requirements. The results of calculations for various types of reactors and fuel cycles are presented. (D.C.W.)

34872 TRANSACTIONS OF THE AMERICAN NUCLEAR SOCIETY 1966 ANNUAL MEETING, JUNE 20–23, 1966, DENVER, COLORADO. Farmakes, Ruth (ed.). Trans. Amer. Nucl. Soc., 9: 1-322(June 1966). (CONF-660606).

Summaries of 346 papers are included. Each summary is title-listed. (D.C.W.)

For titles of individual papers see: 32902, 32903, 32926, 33138–33141, 33145, 33222–33243, 33251, 33372–33374, 33403–33405, 33424–33428, 33440–33444, 33466–33473, 33477, 33597, 33598, 33608–33611, 33713–33715, 33737, 33751, 33754–33756, 33762, 33763, 33669, 33778–33808, 33826–33835, 33852–33856, 33924–33929, 33953–33967, 34105, 34138, 34139, 34481–34505, 34613–34627, 34790–34801, 34873–34886, 34894, 34915–34983, 35049–35091, 35103, 35107, 35108, 35134–35144, 35162–35170, and 35191.

34873 INTRODUCING THE FAULT TREE AS A TOOL FOR NUCLEAR SAFETY ANALYSIS. Griffin, C. W. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 157-9(June 1966).

34874 USING REACTOR SAFEGUARDS REPORTS IN NUCLEAR ENGINEERING CURRICULA: TWO YEARS EXPERIENCE AT ORSORT. Cramer, Eugene N. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 208-9(June 1966).

34875 AXIAL POWER MONITORING WITH AN ON-LINE COMPUTER. Hurley, T. J. Jr. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Trans. Amer. Nucl. Soc., 9: 262-3(June 1966).

34876 ENERGY-OPTIMAL XENON SHUTDOWN TRAJECTORIES. Lewins, Jeffery (Royal Engineers, Hohne, Ger.); Williamson, Theodore J.; Babb, Albert L. Trans. Amer. Nucl. Soc., 9: 281-2(June 1966).

34877 OPTIMAL XENON CONTROL FOR SCHEDULED REACTOR SHUTDOWN. Rosztoczy, Zoltan R. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc., 9: 282-3(June 1966).

34878 FLOW PROFILE AND VIBRATION MEASUREMENTS BY NOISE-ANALYSIS TECHNIQUES. Pekrul, P. J.; Randall, R. L. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 285-6(June 1966).

34879 LOSS OF COOLANT FROM A SIMULATED REACTOR LOOP. Margolis, S. G.; Murphy, J. H.; Redfield, J. A.; Snyder, G. A. (Bettis Atomic Power Lab. West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 298 (June 1966).

34880 DIFFUSION OF FISSION PRODUCTS IN A MOVING GASEOUS MEDIUM. Venerus, Ernest R. (General Electric Co., Schenectady, N. Y.); Ozisik, M. Necati. Trans. Amer. Nucl. Soc., 9: 301-2(June 1966).

34881 PARAMETERS OF FISSION-PRODUCT TRANSPORT AND DEPOSITION. Kress, T. S.; Neill, F. H. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 302-3(June 1966).

34882 ROD-EJECTION ANALYSIS USING THE RELAPSE IBM-7040 CODE. Gruen, G. E.; Moore, K. V. (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 9: 307-8(June 1966).

34883 FAST TRANSIENTS IN LIQUID PLUTONIUM. Carmichael, B. M. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 308-9(June 1966).

34884 TIME-TO-POWER, A NOVEL STARTUP PARAMETER. Bunch, W. L.; Philipp, L. D.; Wood, M. R. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 316(June 1966).

34885 TEN DECADES OF CONTINUOUS NEUTRON-FLUX MONITORING FROM A SINGLE FIXED-POSITION DETECTOR. Popper, G. F.; Lipinski, W. C.; Harrer, J. M. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 316-17(June 1966).

34886 DETECTION OF IN-CORE VOID FORMATION BY NOISE ANALYSIS. Jordan, E. L. (General Dynamics Corp., Ft. Worth, Tex.). Trans. Amer. Nucl. Soc., 9: 317-18(June 1966).

Auxiliaries and Components

Refer also to abstracts 33780, 33913, and 34914.

34887 (DP-MS-66-10) PERFORMANCE AND LONG-TERM STABILITY OF LOW-LEVEL, HIGH-SPEED TRANSISTOR SWITCHES. Goosey, M. H. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Apr. 20, 1966. Contract AT(07-2)-1. 28p. (CONF-660408-1). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From Instrument Society of America, Southeastern Conference and Exhibit, August, Ga.

The performance and long-term stability of high-speed, low-level transistor switches operating in a data acquisition system are described. Results are given of tests on the accuracy, linearity, crosstalk, common mode rejection, resolution, and time and temperature stability for a system using these switches. (auth)

34888 (KR-104) A 100-CHANNEL SCANNER USING FIELD-EFFECT TRANSISTORS AS ANALOG GATES. Oerbeck, I. (Institutt for Atomenergi, Kjeller (Norway)). Mar. 1966. 24p. Dep. mn.

A scanner was developed for use with digital data acquisition systems, and with some modifications it can be used as a fast multiplexer feeding information to a digital computer. Field effect transistors (FET) are used

as switching elements offering advantages in speed, noise and reliability. Results show that thermocouples can be connected directly to the scanner, thus avoiding individual preamplifiers. The scanner has 100 channels, single or differential. The address is shown on nixie display tubes and BCD output is available for printing or punching. The scanner can be operated manually or automatically. Remote operation is possible. (auth)

34889 (NYO-3622-3) APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. Bimonthly Progress Report No. 28, April 1, 1966–May 31, 1966. (Aeroprojects, Inc., West Chester, Pa.). June 1966. Contract AT(30-1)-3622. 14p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The prototype incipient boiling detector has achieved the status of a working instrument, having produced cavitation at a range of reactor temperatures and power levels when tested in the molten potassium loop at Oak Ridge National Laboratory. Stabilization of reactor temperatures at fixed values will enable accurate calibration of the instrument. Assembly of the laboratory ultrasonic flowmeter apparatus is virtually complete and calibration efforts are in progress. Ultrasonic thermometry studies utilizing the "frequency-change" approach were resumed following a deferment. Recently acquired calibration curves have confirmed that the instrument's response to temperature is essentially linear. (auth)

34890 (ORNL-P-2177) IRRADIATION CAPSULE TEMPERATURE CONTROL. Conlin, J. A. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 10p. (CONF-660511-4). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Symposium on Capsule Irradiation Experiments, Pleasanton, Calif.

Two of the most common methods used for irradiation capsule temperature control are the radial gas gap and/or supplemental electrical heat. Both methods have their limits and these limits and their extensions are discussed. (M.O.W.)

34891 (WCAP-3269-62) HYDRAULIC DESIGN OF A ROD CLUSTER CONTROL FUEL ASSEMBLY. Dean, R. A. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Sept. 1965. Contract AT(30-1)-3269. 56p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

A test program was conducted to evaluate the hydraulic characteristics of the RCC control rod system. Two fuel assemblies, one containing a RCC control rod system, were positioned side by side in a single test cell. Tests were run which determined the resistance required to balance the outlet flows from the two assemblies. Flow patterns, made visible by dye injection, indicated the lack of mixing between the outlet of the fuel assembly and the upper core plate. A dual-purpose mixing device was developed which balanced the outlet flows in addition to mixing the coolant so that the average outlet temperature could be recorded by the in-core instrumentation. An analytical model for predicting the pressure-loss coefficients for components with rounded or chamfered entrances is presented. Pressure loss coefficients for the various core components were obtained and agree well with this model. Pressure drop measurements were also made to determine the friction factor for flows in annuli with the radial gaps varying from 0.014″ to 0.053″. These data are presented for flows in the laminar region and for turbulent flows with Reynolds numbers up to 15,000. (auth)

34892 STUDY ON THE LOCALIZATION OF FAILED FUEL ELEMENT CANS IN NUCLEAR REACTORS. I. PRELIMINARY STUDY TO FIND A DETECTOR SITUATED WITHIN THE RADIATION FIELD OF A REACTOR CORE WHICH WILL INDICATE FISSION PRODUCTS IN THE COOLANT UNDER OPERATING CONDITIONS. Terfloth, H. P. (Battelle Institut e. V., Frankfurt am Main). Atomkernenergie, 11: 273-7(July-Aug. 1966). (In German).

Theoretical investigations regarding the possibilities of localizing failed fuel element cans without utilization of nuclear radiation defection methods are dealt with. Using the Shippingport Reactor as an example, the quantities of chemical elements present as contaminants in the coolant are calculated and compared with the expected concentrations of fission product elements in the coolant in case of a defective can. In both cases the concentration of each element at the location of the detector is estimated to be approximately 10^8 atoms per cubic centimeter of coolant. At present, it is practically not possible to detect concentrations of such an order of magnitude without using nuclear radiation measuring techniques. (auth)

34893 NUMERICAL ANALYSIS OF OVERALL RADIATION INTERCHANGE CONFIGURATION FACTOR. Okamoto, Yoshizo (Japan Atomic Energy Research Inst., Ibaraki). Bull. JSME (Jap. Soc. Mech. Eng.), 9: 138-43 (Feb. 1966).

Heat transfer problems with fuel elements in gas-cooled reactors are discussed, and attempts are made toward an accurate evaluation and prediction of the net radiation heat-transfer within an enclosure. Previous solutions are considered. It was demonstrated that the radiation transfer in an enclosure containing $\underline{n}$ discrete surfaces and non-emissive gas can be expressed in terms of derived $\underline{n}$ linear inhomogeneous algebraic equations. One method was devised for determining the radiation process in an industrial furnace in the enclosure containing an emissive surface, black body surface, reflector, and emissive gas. Another method represents generalized solutions of overall configuration factors in the enclosure containing surfaces and emissive gas. An electric network method in terms of the radiation process was also proposed. However, most of these previous methods of detailed analysis are too complicated for practical calculations. Therefore, a method for determining the overall configuration within an enclosure containing many surfaces and emissive gas was developed. The proportion of the radiation energy reaching through the reflector and the gas U_{ij} is used in place of the generalized radiation intensity previously considered. The solution of inhomogeneous algebraic equations represented by the radiation intensities is modified to a method of the iterative calculation of $\underline{n}$'th U_{ij}. This iterative decaying process is useful to obtain solutions by a minimum number of calculations. This new method is useful for determining the overall configuration factor within an enclosure filled with absorbing medium. Even if the enclosure is composed of a complicated shape and a number of surfaces, the conversion method expressed as a matrix form leads to a systematic and efficient solution of the overall configuration factor. (BBB)

34894 PERFORMANCE OF SILVER–INDIUM–CADMIUM ALLOY CONTROL RODS IN PRESSURIZED WATER REACTORS. Smalley, W. R. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 8-9 (June 1966).

34895 COUPLING FOR FUEL AND/OR MODERATOR ELEMENTS OF A NUCLEAR REACTOR. Zimmermann, Heinrich (to Interatom). German Patent 1,213,932. Apr. 7, 1966. Filed July 24, 1962.

The coupling comprises a pair of co-operating coaxial members one of which is telescoped within the other member, and which are latched together against axial separation by locking balls normally trapped in an annular recess situated in the inner surface of the outer member. The trapping is enforced by the inner member, which is movable from its locking position into a release position in which it frees the balls for movement in directions transverse to the axis of the members into positions clear of the annular recess. (Gmelin Inst.)

34896 AUTOMATIC SHUT-OFF DEVICE FOR HETEROGENEOUS NUCLEAR REACTORS. Wirtz, Karl (to Gesellschaft fuer Kernforschung mbH). German Patent 1,213,936. Apr. 7, 1966. Filed Dec. 24, 1962.

As a shut-off device, at least part of the fuel elements are provided with a fusible link at their center. This link separates at a certain temperature with the result that the lower part of the elements drops off. The fusible link is composed of fissionable material which is higher en-

riched than the fissionable material in the fuel. (Gmelin Inst.)

34897 SUPPORTING DEVICE FOR CONTROL ROD DRIVES. Oestreicher, Seymour (to American Machine and Foundry Co.). German Patent 1,214,337. Apr. 14, 1966. Filed Jan. 8, 1960.

Each control mechanism (control rod and associated drive mechanism) is detachably disposed on a perforated mounting grid plate by means of multiple fastening means, which acts as a supporting member with several mounting stations according to the number of the perforations. (Gmelin Inst.)

34898 DEVICE FOR PREVENTING THE BACK-FLOW IN A GAS-COOLED NUCLEAR REACTOR. Benzler, Hartwig. German Patent 1,215,823. May 5, 1966. Filed Sept. 1, 1960.

The vertically arranged coolant channels of a gas-cooled reactor, through which the gaseous coolant is circulated downwards and which contain stacks of fuel element assemblies, are provided with a plurality of axially spaced throttles, preferably perforated plates perpendicular to the channel axis. (Gmelin Inst.)

34899 COOLANT FLOW SYSTEM IN A PRESSURIZED WATER REACTOR. Junkermann, Wolfgang (to Deutsche Babcock and Wilcox-Dampfkessel-Werke, AG). German Patent 1,215,824. May 5, 1966. Filed Oct. 22, 1964.

A consolidated nuclear vapor generator arrangement comprises a closed, spherical pressure vessel, a reactive core with vertical coolant passages, forming an annular chamber with the pressure vessel, pump means mounted external and adjacent to the pressure vessel establishing primary coolant flow up through the core and down through the annular space, and vapor generation means mounted in the annular space for receiving heat from the primary coolant. A shielding annular space is provided between the vapor generation means and the core, the cross section of which is subdivided into separate sections through which the primary coolant flows either up to the pumps or downward to the lower end of the core, the direction of flow being opposite in adjacent sections. (Gmelin Inst.)

34900 METHOD AND APPARATUS FOR EXTINGUISHING REACTOR FIRES. Costes, Didier (to Commissariat a l'Energie Atomique). German Patent 1,215,828. May 5, 1966. Priority date Aug. 7, 1962, France.

The apparatus for extinguishing a chemical reaction, e.g., a fire, in a nuclear reactor channel comprises a magazine for storage of a noncombustible material in divided form, connecting line means selectively operable to connect the magazine with a selected reactor channel, means for feeding said material from the magazine through the connecting line means to the selected channel, and means for retaining within said channel the material fed to. (Gmelin Inst.)

34901 ROD HANDLING EQUIPMENT FOR NUCLEAR REACTOR. Antonsen, Knud; Bell, Francis R.; Harris, Arthur M.; Rosenberg, Richard. (to General Dynamics Corp.). U. S. Patent 3,253,995. May 31, 1966. Filed Sept. 17, 1963.

A rod-handling machine is provided for use with a top-loading nuclear reactor having the rods positioned vertically and held by a grid-type arrangement at their lower ends within the core. The machine supports the rod at its lower end so that the rod element is maintained in compression and engages the rod element at another point spaced above its lower end to maintain the element steady as it is moved into and out of the reactor. The machine handles the rod with its upper end free so that it is available for engagement by another device, such as a refueling machine. The means for guiding and supporting the rod element are provided on a leg that is lowered through a reactor passageway into the core and alongside the rod. (B.L.M.)

34902 REFLECTOR AND COOLANT SEALING STRUCTURE FOR GAS COOLED NUCLEAR REACTOR. Kalk, W. A.; Petersen, J. F. (to U. S. Atomic Energy Commission). U. S. Patent 3,260,650. July 12, 1966.

A neutron reflector and coolant sealing structure for a gas-cooled nuclear reactor are described. The reflector is composed of a series of vertically disposed blocks arranged in side-by-side spaced-apart relation around the periphery of the core, each block being pivotably supported at its lower end for movement toward and away from the core. The blocks have longitudinally and transversely extending grooves in their opposing side walls wherein sealing means are disposed to limit flow of coolant radially by the blocks and vertically along the grooves between the blocks. A segmented expandable ring supported by the inner walls of the reactor is spring biased into engagement with the upper ends of the blocks. (AEC)

34903 QUICK OPENING LATCH AND ANTI-VIBRATION LOCK FOR NUCLEAR REACTOR SAFETY ROD. Manoll, R. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,261,760. July 19, 1966.

A device for attaching neutron poison material to a safety rod used to control or halt neutron fission in a nuclear reactor is described. The device is designed to prevent vibration of the attached neutron poison material due to coolant flow and turbulence while at the same time permit easy and quick removal and replacement of the neutron poison. The device includes a pivoted member for attaching the poison and a pin arrangement to prevent the pivoted member from coming loose. (AEC)

Criticality Studies

Refer also to abstracts 34486, 34489, 34495, 34500, 34505, and 35164.

34904 (CONF-660606-3) FLUX DIPPING AND PEAKING IN FOILS USED IN THERMAL DISADVANTAGE FACTOR MEASUREMENTS. Dunn, F. E. (Knolls Atomic Power Lab., Schenectady, N. Y.). June 20, 1966. Contract W-31-109-eng-52. 14p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Nuclear Society Meeting, Denver.

Two sets of experiments were performed: one set used Dy foils with a small absorption cross section; the other set used ^{235}U foils with large absorption cross section. Thermal disadvantage factors were measured, both for $\frac{1}{4}$ inch outer diameter rods containing 26 wt.% UO_2 (96% ^{235}U) in ZrO_2 and for .57 inch outer diameter rods containing 1 wt.% ^{233}U in ThO_2. These rods were placed in a square array in a light water moderator. Both bare and Cd covered 2 wt.% Dy–Al foils, .005 inches thick were used for these measurements so that the effects of epithermal activities could be eliminated. In the other experiments 17.5 wt.% ^{235}U Al foils of varying thicknesses from 2 to 25 mils were used. These measurements were made on hexagonal fuel rod arrays. (M.O.W.)

34905 (GA-7059) ADEQUACY OF FAST AND INTERMEDIATE CROSS SECTION DATA FROM MEASUREMENT OF NEUTRON SPECTRA IN BULK MEDIA. Russell, J. L. Jr.; Profio, A. E. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 27, 1966. Contract AT(04-3)-167. 17p. (CONF-660303-45). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Physical Society, Conference of Neutron Cross Section Technology, Washington, D. C.

Methods used to calculate intermediate neutron spectra in fast reactors are suspect because of inadequacies in cross section data and as well as approximations used in preparing (group averaging) cross section data for transport codes. Direct measurement of neutron spectra in bulk media provides a means of evaluating discrepancies. The status of spectrum measurements is reviewed, preliminary results of spectrum measurements are discussed, and some new measurement concepts are described. (auth)

34906 (NAA-SR-Memo-11799) A SUMMARY OF THE CALCULATED CHARACTERISTICS OF THE EPITHERMAL CRITICAL ASSEMBLIES 1 THROUGH 13. Tuttle, Robert J. (Atomics International, Canoga Park, Calif.). Jan. 12, 1966. Contract AT-11-1-GEN-8. 92p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The results of criticality calculations and perturbation theory calculations of the prompt neutron lifetime, effective delayed neutron fraction and average fission importance are tabulated for the ECEL Cores 1-13. The flux and adjoint spectra are tabulated and presented in graphical form. Material specifications and the cross section library used in the calculations are also recorded. A bibliography of the experimental program is provided. (auth)

34907 (ORNL-TM-1213) STATIC AND DYNAMIC TRANSPORT CALCULATIONS FOR PULSED-NEUTRON EXPERIMENTS WITH SPHERES OF URANYL NITRATE SOLUTION. Magnuson, D. W. (Oak Ridge National Lab., Tenn.). Apr. 26, 1966. Contract W-7405-eng-26. 15p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

In static reactor calculations, the neutron balance between production by fission and loss by leakage and absorption is artifically maintained by adjusting the vaue of ν, which is equivalent to adding neutrons at fission energies. In dynamic reactor calculations, the neutron balance between production and losses may be maintained by adding neutrons which have a spectrum proportional to the fluxes and inversely proportional to the neutron velocity. Since the neutrons added in the two methods have unequal importances, the corresponding static and dynamic reactivities determined by these two methods are unequal. Calculations on some simple systems were made for application to pulsed-neutron experiments on spheres of uranyl nitrate solution. (auth)

34908 (UCRL-14719-T) REACTOR NOISE ANALYSIS FROM OBSERVATIONS ON THE HIGH-ENERGY RADIATION FROM THE REACTOR CORE. Gelinas, R. J. (Lawrence Radiation Lab., Univ. of California, Livermore); Osborn, R. K. (Michigan Univ., Ann Arbor). [1966]. Contract W-7405-eng-48. 26p. (CONF-660206-18). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From Symposium on Neutron Noise, Waves, and Pulse Propagation, Gainesville, Fla.

Reactor noise analyses are conventionally performed by using neutron detectors to make direct observations on the fluctuations in the neutron distribution within a reactor core. A theory is presented for the interpretation of a noise experiment performed instead of using a photon detector to measure the fluctuations in the high energy radiation distribution from the reactor core. In practice one would choose to detect the high energy ($E_0 \geq 5$ Mev) radiation, because in many instances there is a negligible fraction of delayed photons at these energies. The many groups of low energy delayed photons only complicate an otherwise practical and direct interpretation of such an experiment. The type of system that is considered here is one in which a photon detector (and its associated discriminating, counting, and recording equipment) is placed outside a reactor core. Particular attention is devoted to the theoretical description of the observables of an experiment. Two commonly used measures of fluctuations are a variance and a power spectral density; the analysis is accordingly couched in these terms. Applying consistent P-1 approximation procedures to the neutron distributions, the set of transport equations is solved for the type of system described above and spatially dependent expressions for the power spectral density of detected particles are obtained. Upon comparison with the corresponding expressions from a conventional neutron noise analysis, it is found that the same neutron correlation information is obtainable in principle by a photon detecting noise analysis as by conventional techniques. (M.O.W.)

34909 (WAPD-T-1781) ANALOG STUDIES OF XENON OSCILLATIONS: THE EFFECT OF COOLANT RECIRCULATION ON SPATIAL STABILITY. Chock, K. T.; Kaplan, S.; Margolis, S. G.; Lane, C. M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1965. Contract AT(11-1)-Gen-14. 10p. (CONF-650602-41). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

The results are presented of an analog simulation of a large reactor to study the stability aspects from the standpoint of xenon oscillations. (M.O.W.)

34910 NEUTRON TRANSPORT AND REACTOR KINETICS. Belleni-Morante, A. (Univ., Florence). Energ. Nucl. (Milan), 13: 304-11(1966).

The reactor kinetics equation is deduced directly from the Boltzmann equation and showed that it is a differential equation of infinite order. It was assumed that the neutron distribution function was not separable into a function of time and a function of the remaining variables. Weighting functions were not used. Some numerical results were found for spherically symmetric homogeneous systems. (auth)

34911 MEASUREMENT OF THE FAST NEUTRON SPECTRUM IN A FAST REACTOR BY A ^{6}Li SEMICONDUCTOR SPECTROMETER. Windsor, Margaret E.; Wright, S. B. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy: Pt. A and B, 20: 465-71(June 1966).

A measurement of the fast neutron spectrum in the reactor Zebra in the range 500 kev to 3.8 Mev is described, and the result is compared with a theoretical spectrum. Use of semiconductor spectrometers for measurement of fast neutron spectra in thermal reactors is discussed. (auth)

34912 EFFECTIVENESS OF MULTIPLE CONTROL RODS. Nakamura, Shoichiro (Hitachi Ltd., Japan). J. Nucl. Sci. Technol. (Tokyo), 3: 219-26(June 1966).

A new approximate method for calculating the effectiveness of multiple control rods fully inserted in a reactor is described. This method is applicable to a bundle of many control rods, regardless of the number of rods, as well as to an array of a limited number of few rods. Using either the sink model or the well model, a reactor equation of kernel form is obtained. The reactor equation is a two-dimensional diffusion equation with two-group diffusion kernel. In order to facilitate numerical computation of the eigenvalue, the integral equation is reduced to a set of linear homogeneous equations, by dividing the reactor into a large number of unit cells containing at most one control rod. The method was programmed for the IBM 7090, the code being given the designation ELC. The iterative procedure used converges much faster than the standard accelerated finite-difference programs. Using the ELC code, the effectiveness of an array of four control rods fully inserted in a cylindrical reactor was calculated. The results are in good agreement with those found by the Scaletter-Nordheim method. In the case of a large number of control rods, there is no alternative method to be compared with. (auth)

34913 TIME OPTIMAL DIGITAL COMPUTER CONTROL OF NUCLEAR REACTORS. I. CONTINUOUS TIME SYSTEM. Monta, Kazuo (Nippon Atomic Industry Group, Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 3: 227-36(June 1966).

Time optimal control of nuclear reactors was studied using Pontryagin's maximum principle. Since the results are intended for application in a digital computer control system, restrictions on the maximum reactivity and on the maximum over (under)-shoot of reactor power are imposed to derive a practical control pattern. A study of continuous time systems is attempted for the purpose of deriving the basic characteristics of optimal solution and providing useful guides to future work on discrete time systems, including digital computer. To facilitate synthesis of optimal control, the reactor model is simplified with the use of a one-group model for delayed neutron and prompt jump approximations. As a result, the time optimal control pattern is found to be uniquely determined in a delayed neutron density (or reactor power) vs. reactivity phase plane for any range of power variation. The optimal control law is simple, and can be adopted in a feedback control system. (auth)

34914 CORRELATION METHODS IN NUCLEAR REACTOR MEASUREMENT TECHNIQUES. Bastl, W. Regelungstechnik, 14: 56-63(Feb. 1966). (In German).

The fundamental mathematical connections with reference to correlation analysis are described. The autocorrelation function, cross correlation function, Fourier transforms, power spectra, and cross power spectra are defined. Determination of the subcritical multiplication factor by means of spectral analysis and correlation analysis is outlined. Illustrations of the method are given. Transmission properties of a reactor may be determined by such techniques, as well as elimination of effects in power reactors caused by very small fluctuations in several variables. Fuel losses in a homogeneous reactor are examined; the autocorrelation function and power spectrum of such a reactor under normal conditions and with heavy loss of fuel element are illustrated. Boron deposition in the reactor, resulting in localized boiling, causes resonances in the power spectrum in very close agreement with theoretical predictions. Frequency correlations for cross stream heat exchangers are also analyzed by this technique. (BBB)

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34916 KERNEL METHOD FOR CALCULATING THE SPATIAL DISTRIBUTION OF UNCOLLIDED NEUTRONS AROUND FUEL RODS. Woodruff, G. L. (Univ. of Washington, Seattle); Thompson, T. J.; Kaplan, I.; Lanning, D. D. Trans. Amer. Nucl. Soc., 9: 116-17(June 1966).

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34966 SPECIAL PROBLEMS ASSOCIATED WITH THE DETERMINATION OF LARGE NEGATIVE REACTIVITY CHANGES IN FAST SYSTEMS. Hansen, Gordon E. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 238(June 1966).

34967 APPLICATION OF CORRELATION TECHNIQUES TO DETERMINATION OF SUBCRITICAL REACTIVITY. Albrecht, Robert W. (Univ. of Washington, Seattle). Trans. Amer. Nucl. Soc., 9: 238(June 1966).

34968 SPATIALLY DEPENDENT SPECTRA IN A PARAFFIN MODERATOR AND A PARAFFIN-MODERATED SUBCRITICAL ASSEMBLY. Cerbone, R. J.; Slovacek, R. E.; Fullwood, R. R.; Gaerttner, E. R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 9: 239-40(June 1966).

34969 CALCULATION OF THE THERMAL-NEUTRON IMPORTANCE FUNCTION IN HETEROGENEOUS LATTICES. Greenspan, Ehud; Cady, K. B. (Cornell Univ., Ithaca, N. Y.). Trans. Amer. Nucl. Soc., 9: 242-3(June 196

34970 SOME APPLICATIONS OF THE THERMAL-NEUTRON IMPORTANCE FUNCTION TO UNIT-CELL STUDIES. Greenspan, Ehud; Cady, K. B. (Cornell Univ., Ithaca, N. Y.). Trans. Amer. Nucl. Soc., 9: 243-4(June 1966).

34971 CALCULATION OF THERMAL-NEUTRON SPECTRA IN WATER-MODERATED ASSEMBLIES. Kellman, S.; Nakache, F. R. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 9: 244(June 1966).

34972 RESONANCE CALCULATIONS FOR MULTIPLE-BODY ANNULAR RINGS WITH AN INTERSTITIAL SCATTERER. Cohen, S. C.; Stevens, C. A. (General Atomics, San Diego). Trans. Amer. Nucl. Soc., 9: 255-6(June 1966).

34973 DIRECT METHOD FOR MEASURING RESONANCE ESCAPE PROBABILITY IN THORIUM-WATER LATTICES. Stam, Ephraim (North Carolina State Coll., Raleigh); Robeson, Andrew. Trans. Amer. Nucl. Soc., 9: 257-8(June 1966).

34974 VOID-FRACTION-DEPENDENT RESONANCE-ESCAPE PROBABILITY AND THERMAL-UTILIZATION MEASUREMENTS USING AN EXPONENTIAL ASSEMBLY. Kleijn, H. R. (Reactor Instituut, Delft, Netherlands). Trans. Amer. Nucl. Soc., 9: 258-9(June 1966).

34975 ANALOG COMPUTER TECHNIQUES IN CRITICAL EXPERIMENTS. Shomo, R. B.; Hamilton, G. N.; Leamer, R. D. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 261(June 1966).

34976 FURTHER USE OF AN ON-LINE COMPUTER IN REACTOR PHYSICS EXPERIMENTS. Cohn, Charles Erwin (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 262(June 1966).

34977 EFFECT OF DELAYED NEUTRONS ON REACTOR EXCURSIONS WITH RAMP REACTIVITY INSERTION. Canosa, Jose (General Electric Co., Pleasanton, Calif.). Trans. Amer. Nucl. Soc., 9: 268-9(June 1966).

34978 ON THE EFFECT OF RAMP REACTIVITY INSERTIONS IN THE FUCHS-NORDHEIM REACTOR EXCURSION MODEL. Kazi, A. H. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 9: 269-70(June 1966).

34979 IMPROVED MODEL FOR ANALYSIS OF FAST TRANSIENT REACTIVITY EFFECTS IN LOW-ENRICHED OXIDE-FUELED REACTORS. Houghtaling, J. E. (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 9: 270(June 1966).

34980 USE OF OSCILLATION TESTS TO INVESTIGATE FLUX TILTING. Foulke, Larry R.; Gyftopoulos, Elias P. (Massachusetts Inst. of Tech., Cambridge). Trans. Amer. Nucl. Soc., 9: 271-2(June 1966).

34981 APPLICATION OF A HYBRID COMPUTER TO THE ANALYSIS OF TRANSIENT PHENOMENA IN A FAST REACTOR CORE. Sanathanan, C. K.; Carter, J. C.; Bryant, L. T.; Amiot, L. W. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 272(June 1966).

34982 STABILITY CONSIDERATIONS WITH CONVECTION TIME DELAYS. Jacobowitz, Howard J. (New York Univ., N. Y.); Akcasu, A. Ziya; Shotkin, Louis M. Trans. Amer. Nucl. Soc., 9: 272-3(June 1966).

34983 THE DIRECT MEASURABILITY OF REACTIVITY (IN $) AND ITS EXPERIMENTAL BOUNDS (THE "BRACKETING-PROCEDURE"). Gozani, Tsahi (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Amer. Nucl. Soc., 9: 274-5(June 1966).

34984 PROCESS AND DEVICE FOR MEASURING THE EXCESS REACTIVITY FOR A REACTOR IN THE SUBCRITICAL REGION. Flachs, Philippe; Lapicque, Georges; Nicolo, Georges (to Commissariat a l'Energie Atomique). German Patent 1,213,934. Apr. 7, 1966. Priority date June 22, 1961, France.

A process for indicating when the excess reactivity of a nuclear reactor in a subcritical state rises above a predetermined threshold value comprises providing within the reactor a source of neutrons, the intensity of which decays exponentially, measuring the neutron flux after the neutrons have traversed the reactor core by means of a detector which thereby produces a potential proportional to the flux, and producing by means of a time-scaled potentiometric device a reference potential which is initially adjusted to the original value of the potential produced by the detector, the reference potential being arranged to decrease as a function of a predetermined time period of the device according to the same exponential law as the intensity of the source. (Gmelin Inst.)

34985 INVESTIGATION OF A DIRECT METHOD FOR MEASURING THE RESONANCE ESCAPE PROBABILITY IN THORIUM-WATER LATTICES. Stam, Ephraim. Blacksburg, Va., Virginia Polytechnic Inst., 1966. 74p. Thesis.

A direct method for measuring the resonance escape probability, p, in thorium-water lattices was experimentally examined. The system under investigation consisted of a square, close-packed, lattice of hollow aluminum-clad thorium metal slugs in water, spaced to give a water-to-thorium ratio of 2 to 1 by volume (water to metal 1.45 to 1). A substitute lattice, in which the thorium was replaced by lead, was also used to give the same scattering properties as thorium but no resonance capture. The neutron source consisted of a fission plate made of a disc of U-235 mounted at the end of a Cd-covered aluminum tube that conducted a beam of neutrons from inside the thermal column of the VPI reactor into the lattice. Cd-covered indium foils were used to measure flux traverses in two perpendicular directions, parallel to the slugs (denoted by $\parallel$) and perpendicular to the slugs (denoted by $\perp$). The curves of Ar^2 vs r, where A is the normalized relative activation of the foils corrected for activation by epithermal neutrons from the primary source (reactor), were integrated to infinity and the ratio of the integrals in the thorium and lead lattices yielded p. It was found that $p_\perp$ and $p_\parallel$ differed by only one percent, which was within the experimental error. It was therefore concluded that there was no anisotropy in the resonance absorption and the average of the two values, 0.88 ± 0.015, was taken as the value of p for the lattice. The experiment yielded also the age τ to indium resonance energy: in thorium lattice, $\tau_\perp = 44 \pm 2\ cm^2$, $\tau_\parallel = 46 \pm 2\ cm^2$; in lead lattice, $\tau_\perp = 47 \pm 2\ cm^2$, $\tau_\parallel = 49 \pm 2\ cm^2$. (Dissertation Abstr.)

Design and Feasibility

34986 NUCLEAR REACTOR WITH GASEOUS COOLANT, SOLID MODERATOR AND HEAT EXCHANGERS INSTALLED IN THE REACTOR'S PROTECTIVE HOUSING. Coudry, Michel; Treille, Pierre (to Indatom). German Patent 1,213,935. Apr. 7, 1966. Priority date May 28, 1962, France.

The nuclear reactor installation given comprises a shield assembly defining an internal pressure enclosure; a reactor core in the enclosure; a heat-exchange assembly in the enclosure spaced from the core and comprising a plurality of heat exchange tubes; means for circulating a gaseous primary coolant through the core and past the heat exchange tubes; means for circulating a secondary cooling fluid through the heat exchange tubes; means providing a flow circuit for the secondary fluid externally of the shield assembly; a servicing chamber in the enclosure spaced from the core and from the heat exchange assembly; wall means shielding the chamber from the core and heat exchanger assembly in respect to radiations; passage means through the shield assembly communication with the chamber to provide access thereto; and flow means connecting the heat exchange tubes to the external flow circuit, the connecting means including conduits connected to the external circuit and extending through the shield assembly. (Gmelin Inst.)

34987 HETEROGENOUS NUCLEAR REACTOR. Kornbichler, Heinz; Kluge, Hans (to Licentia Patent-

Verwaltungs-GmbH). German Patent 1,214,805. Apr. 21, 1966. Filed Mar. 20, 1958.

The ratio of the moderator volume to the fuel volume is chosen in such a way that the reactivity decreases if the density of the steam increases because of its change to the liquid state but remains practically constant if the density of the steam changes without changing to the liquid state. (Gmelin Inst.)

34988 ARRANGEMENT OF A MULTI-ZONE REACTOR WITH NATURAL URANIUM FUEL. Bagge, Erich; Diebner, Kurt; Engel, Helmut; Locke, Gerhard (to Ursula Diebner, geb. Sachsse). German Patent 1,215,822. May 5, 1966. Filed May 30, 1959.

The zones of the reactor are charged alternatively with heavy water and graphite as moderator, the heavy-water zones having an excess reactivity such as to ensure that they supply excess neutrons to the surrounding natural uranium-graphite zones and thus increase the specific power, at the same time improving the conversion-ratio of ^{238}U into plutonium. (auth)

34989 AXIALLY SYMMETRIC HETEROGENEOUS NUCLEAR REACTOR, THE REACTIVITY OF WHICH IS CHANGED BY VARYING STOPPING CHARACTERISTICS OF MODERATOR. Kuelz, Helene (to Siemens-Schuckertwerke AG). German Patent 1,215,829. May 5, 1966. Filed Sept. 29, 1960.

The core of the reactor is composed of at least two different, immiscible moderators of solid material or enclosed in containers if they are in the liquid state, which may be exchanged during operation. The shape of the moderator elements or the successive layers of different moderator material are chosen in such a way that the neutron spectrum is shifted symmetrically from the middle plane of the core to its axial ends. (Gmelin Inst.)

34990 HYDRAZINE REACTOR AND PROCESS. Gustavson, Marvin R.; Miller, Roger I. (to Aerojet-General Nucleonics). U. S. Patent 3,250,683. May 10, 1966. Filed Mar. 8, 1960.

A homogeneous reactor is described for chemical processing which is particularly adapted to the production of anhydrous hydrazine from ammonia. A homogeneous fluid is established by mixing fissionable material and liquid ammonia, and the fluid is controllably dispersed into a critical mass to establish a fission process in which neutrons emitted from the process are thermalized by the moderating properties of the ammonia so as to sustain the fission reaction. The anhydrous hydrazine is separated from the ammonia, and the gaseous N_2 and H_2 formed are combined with additional NH_3 for recirculation through the critical volume. (B.L.M.)

34991 NUCLEAR REACTOR AND COOLING AND MODERATING ARRANGEMENT THEREFOR. Abbott, William E. (to Westinghouse Electric Corp.). U. S. Patent 3,253,997. May 31, 1966. Filed Dec. 3, 1962.

A pressurized liquid reactor to provide relative flexibility with respect to thermal, hydraulic, and reactivity conditions includes a fissile fuel core made up of a number of elongated fuel subassemblies including a number of tubularly shaped elongated clad elements supported in a lattice structure. Some of the elements distributed interstitially throughout the subassemblies contain only a moderator material such as ZrH_4, and the remaining elements contain only fuel material. A quantity of coolant-moderator liquid circulates longitudinally through the core and the fuel assemblies, and control rods are disposed in the core. The moderator liquid is a mixture of light water and D_2O. (B.L.M.)

34992 NUCLEAR REACTOR. Jens, Wayne H.; Edlund, Milton C.; Barringer, Howard S.; Davidson, John K.; Klotz, Charles E.; Nims, John B.; Miller, Richard S.; Palmer, Ronald G. (to U. S. Atomic Energy Commission). U. S. Patent 3,260,649. July 12, 1966.

A very large liquid-metal-cooled fast reactor consisting of a plurality of vertical, elongated fuel assemblies arranged in an annulus is discussed. The fuel assemblies include a vacant space near the top thereof which is normally filled with coolant passing upwardly through the assembly. The upper reflector thus formed is voided on loss of coolant, thus reducing reactivity. (AEC)

Fuels

34993 (ORNL-TM-1512) AN IRRADIATION TEST OF AVR PRODUCTION FUEL SPHERES IN THE OAK RIDGE RESEARCH REACTOR. McQuilkin, F. R.; Cuneo, D. R.; Prados, J. W.; Long, E. L. Jr.; Coobs, J. H. (Oak Ridge National Lab., Tenn.). June 1966. Contract W-7405-eng-26. 70p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Injection-molded spheres with machined ATJ unfueled graphite shells successfully met the irradiation performance requirements for AVR fuel. The fuel particles in the spheres were melted UC_2 containing highly enriched uranium (93.07%). Thermal analyses showed that the heat transfer between fueled cores and unfueled shells was satisfactory, and not decreased by irradiation. Dimensional and weight changes during irradiation were acceptably small. No failures of fuel particle coatings were found for burnups in the range of 7 at. % (FIMA). Migration of solid fission products out of the spheres was quite low, as was fission-gas release during irradiation. (auth)

34994 (ORNL-TM-1513) CALCULATED DENSITIES OF COATED NUCLEAR FUEL PARTICLES. Pilloton, R. L. (Oak Ridge National Lab., Tenn.). July 1966. Contract W-7405-eng-26. 67p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Calculation of densities is often needed in the fabrication of coated nuclear fuel microspheres. Frequently encountered values are presented as calculated curves of microsphere densities for kernel diameters of 100 of 1200 μ, kernel densities of 8 to 14 g/cm^3, coating densities of 0.6 to 2.2 g/cm^3, and overall particle diameters of 100 to 1400 μ. The surface area of 1000 spheres, their volume, the number, and the surface area of one gram of spheres of various diameters and densities are included. (auth)

34995 EMISSION OF LONG-LIVED GASEOUS FISSION PRODUCTS FROM A SMALL HOLE IN THE CLADDING OF A REACTOR FUEL ELEMENT. French, R. L. D. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). J. Nucl. Energy: Pt. A and B, 20: 451-64(June 1966).

A general expression is derived to show the effect of fuel-element and hole dimensions on the diffusion of long-lived fission gases from a small hole in a reactor fuel-element can. This expression is combined with a simplified source-term to yield the corresponding reactor coolant activity levels. Results are given for the particular cases of 5.8-day ^{133}Xe, 9.2-hr ^{135}Xe, 4.4-hr ^{85m}Kr, and 2.8-hr ^{88}Kr diffusing from a hole in the canning of a Calder-type fuel element. The effects of variations in hole radius and in hole length are presented graphically. It is shown that the ratio of the activities $^{133}Xe : ^{135}Xe : ^{85m}Kr : ^{88}Kr$ increases from 2 : 1 : 0.4 : 1 for bare uranium to 78000 : 460 : 0.6 : 1 for fission products diffusing through a hole of small radius. Other factors effecting fission-gas activity levels in the coolant are also considered. (auth)

34996 IN SITU MEASUREMENT OF FISSION PRODUCT GAS DENSITY. Ledwidge, T. J.; Maidment, L. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Nucl. Eng., 11: 380-1(May 1966).

A method for measuring the internal gas pressure in irradiated fuel tubes, which does not require orthodox pressure transducers is described. The method is based on the fact that resistance to the motion of a falling body is proportional to the density of the medium through which the body is falling for Reynolds numbers greater than 100. Consequently the time taken for a body to fall a given distance through the medium is a function of the medium density and, if the medium temperature is constant, is a function of the medium pressure. (G.O.Y.)

34997 DEVICE FOR FIXING FUEL PLATES IN FUEL ELEMENTS FOR NUCLEAR REACTORS AND A FUEL

PLATE ESPECIALLY SUITED TO THIS. Remmel, Anton (to NUKEM). German Patent 1,213,933. Apr. 7, 1966. Filed Apr. 2, 1964.

The fuel element consists of fuel plates mounted between two slotted side plates. The fuel plates are fitted into the slots and rolled in place, the roller being provided with a shoulder which rolled in the slot adjacent to the fuel plate to be mounted. (Gmelin Inst.)

34998 NUCLEAR FUEL ELEMENT. Steinberg, M.; Farber, G.; Gurinsky, D. H. (to U. S. Atomic Energy Commission). U. S. Patent 3,261,757. July 19, 1966.

A nuclear fuel element for use in a chemonuclear fuel reactor comprising an inner core made up of an alloy of (70–90 weight percent) palladium and (1.0–30 weight percent) uranium, said core being covered by a thin layer of palladium (0.2 to 6 microns thick) is described. (AEC)

34999 ORDERED BED NUCLEAR FUEL ASSEMBLIES. Winsche, W. E. (to U. S. Atomic Energy Commission). U. S. Patent 3,262,859. July 26, 1966.

Ordered beds of spherical elements suitable for use as nuclear fuel assemblies are given. A bed of spherical particles formed in accordance with this invention would consist of a series of layers of spheres, the spheres in any layer forming corners of squares and those in the next layer located in the cusps formed in an adjacent layer. All outside spheres are tangent to the container walls and the orientation is established by the use of a template for the bottom layer. This type of bed permits a preselected packing density, vertical coolant flow channels, and predictable distribution of fuel. (AEC)

Power and Power-Breeder Reactors

Refer also to abstract 34140.

35000 (BAW–3576–2) ZERO POWER TESTS, PM-1 CORE II. Batch, M. L. (Babcock and Wilcox Co., Lynchburg, Va.). June 1966. Contract AT(30-1)-3576. 31p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The zero power tests on PM-1 Core II were performed as follows: detector response was measured at specific locations during core submersion and approach to criticality, the temperature coefficient was measured up to 170F (the results fit the linear function: $d\rho/dT = -0.084\ T - 0.37$ (in units of ¢/F)), stuck-rod criteria and core uniformity were confirmed, and total excess reactivity was measured using boric acid techniques; the result is 10.09% Δk/k. All tests except core submersion detector response were performed with stainless steel mockups of thermal shields and the pressure vessel. (auth)

35001 (BNWL–222) PHYSICS RESEARCH QUARTERLY REPORT, OCTOBER–DECEMBER 1965. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 14, 1966. Contract AT(45-1)-1830. 27p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The three following studies were made during this period: integrated burnup equations for U–Pu systems, criticality safety of PuO_2–SS driver fuel in the FFTF, and applications of pulsed neutron measurements in very large systems. The results are presented for all of the above. Both theoretical and analytical studies were made for neutron transport in water. (M.O.W.)

35002 (BNWL–223) PRODUCTION AND INDIFFERENCE PRICING OF TRANSURANIUM ISOTOPES. Deonigi, D. E.; Eschbach, E. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1966. Contract AT(45-1)-1830. 91p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The computed rates at which ^{237}Np, ^{238}Pu, ^{241}Am, ^{242}Cm and ^{244}Cm are incidentally produced by simulated power reactors are reported. Also shown is the extent to which some power reactor fueling methods can be altered to increase the production and purity of ^{238}Pu and ^{244}Cm. An explanation of the indifference price concept is introduced in order to assess the effect of various ^{238}Pu and ^{244}Cm credits on the equitable price of the precursor, or target, isotopes. Other included calculations show how various credits for transuranium isotopes would affect fuel-cycle costs both for normal fueling methods and for altered fueling methods in power reactors. (auth)

35003 (BNWL–232) PHYSICS DESIGN ASPECTS OF PLUTONIUM RECYCLE. Dawson, F. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1966. Contract AT(45-1)-1830. 34p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The physics design aspects of plutonium utilization in thermal reactors are presented by reviewing the basic data on plutonium, design analysis method evaluation, effects of plutonium on reactivity coefficients, and plutonium burnup characteristics. (B.G.D.)

35004 (CONF-660308) COMMERCIAL PLUTONIUM FUELS CONFERENCE, MARCH 1-2, 1966, WASHINGTON, D. C. (Atomic Industrial Forum, Inc., New York. Edison Electric Inst., New York. American Nuclear Society, Hinsdale, Ill.). Contract AT(45-1)-1830. 304p. Dep. mn. CFSTI $3.00 cy, $1.50 mn.

Separate abstracts were prepared for 20 of the 24 included papers. For abstracts of the remaining papers see CONF 660308 in the report number index. (M.O.W.)

For abstracts of individual papers see: 33409, 33410, 33549–33552, 33837, and 35005–35017.

35005 (CONF-660308, pp 6-13) AEC PROGRAMS AND REQUIREMENTS FOR PLUTONIUM. Shaw, Milton (Division of Reactor Development and Technology (AEC), Washington, D. C.).

A discussion is presented of the AEC's utilization of plutonium in thermal power and fast breeder reactors. The timing of supply and demand of plutonium is also discussed. (M.O.W.)

35006 (CONF-660308, pp 14-24) PLUTONIUM FUELS: U. S. UTILITY PROGRAMS AND REQUIREMENTS. Wagner, Harvey A.; Beekman, Myron C. (Detroit Edison Co., Mich.).

The utilization of plutonium in U.S. power reactors is briefly described. The research work done by independent electric companies on nuclear power plants utilizing plutonium is outlined. (M.O.W.)

35007 (CONF-660308, pp 33-5) USE OF PLUTONIUM IN THE CANADIAN REACTOR PROGRAMME. Gray, J. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario)).

A brief discussion is presented on the use of plutonium in Canadian reactors. (M.O.W.)

35008 (CONF-660308, pp 36-44) THE DEVELOPMENT OF PLUTONIUM BEARING FUEL IN THE EUROPEAN COMMUNITY. Gueron, J. (European Atomic Energy Community).

The utilization of Pu in fast and thermal reactors and the manufacture and study of plutonium bearing fuel in EURATOM are discussed. Plutonium demands are also discussed. (M.O.W.)

35009 (CONF-660308, pp 60-8) PLUTONIUM: PAST, PRESENT, FUTURE. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.).

The discovery of Pu is reviewed. Present and future uses by the AEC are described. (M.O.W.)

35010 (CONF-660308, pp 71-6) MANAGEMENT OF PLUTONIUM FOR FUEL USE. Baranowski, F. P. (Division of Production (AEC), Washington, D. C.).

AEC has underway major development programs to adapt plutonium for use as a reactor fuel. During the next few years the plutonium needed for these development efforts will be supplied from three main sources: material received from domestic power reactors, material received from United Kingdom, and supplementary material as necessary from the AEC production reactors. It is unlikely that the plutonium from diverse sources will be uniform in isotopic assay or will be in the desired chemi-

cal form. The AEC does not plan on installing specific facilities for doing the necessary blending or making desired compounds if satisfactory services can be commercially procured by the users. (M.O.W.)

35011 (CONF-660308, pp 77-85) COMMERCIAL PLUTONIUM: ITS AVAILABILITY AND COMPOSITION. Stanford, Russell E. L.; Moore, Charles R. (Nuclear Fuel Services, Inc., [Washington, D. C.]).

Data giving the quantity of Pu to be recovered from spent fuels are listed. The data were obtained from various BWR and PWR power plants. (M.O.W.)

35012 (CONF-660308, pp 112-20) THE TIMING OF COMMERCIAL APPROACHES TO LARGE-SCALE UTILIZATION OF PLUTONIUM. Zebroski, E. L. (General Electric Co., San Jose, Calif. Advanced Products Operation).

The demands for Pu are discussed in terms of the future development of fast and thermal reactors. The timing of Pu fuel facilities is discussed. (M.O.W.)

35013 (CONF-660308, pp 196-201) IS FINANCING NUCLEAR POWER A PROBLEM? Childs, John F. (Irving Trust Co., New York); Reichle, Leonard F. C. (Ebasco Services, Inc., New York).

The economics of nuclear power plants are briefly compared to those of fossil fueled plants. Future aspects are outlined. (M.O.W.)

35014 (CONF-660308, pp 229-42) PLUTONIUM UTILIZATION IN BOILING WATER REACTOR POWER PLANTS. Crowther, R. L.; Evans, E. A.; Levy, S.; MacNabb, W. V. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.).

The feasibility, compatibility, and economics for using Pu in BWR power plants are discussed. (M.O.W.)

35015 (CONF-660308, pp 243-9) PLUTONIUM UTILIZATION IN PRESSURIZED WATER REACTORS. Graves, H. W. Jr. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.).

The effect of using mixed plutonium-uranium feed assemblies on the design and operating characteristics of a PWR are discussed. Experimental information developed in the Saxton Plutonium Program is used to illustrate the differences between ^{235}U and the fissile plutonium isotopes on design. Agreement between analysis and experiment is seen to be quite acceptable. (auth)

35016 (CONF-660308, pp 262-77) STATUS OF FAST BREEDER REACTOR CORE DESIGN. Pursel, C. A. (Argonne National Lab., Ill.); Eggen, D. T. (Atomics International, Canoga Park, Calif.); Wright, J. H. (Westinghouse Electric Corp., Pittsburgh, Pa.).

The status of fast breeder reactor core design is discussed with respect to core heat transfer and hydraulics and their relation to energy costs and plutonium utilization. Core heat transfer and hydraulics enter into fast breeder plant design through consideration of plutonium doubling time and pumping power. (M.O.W.)

35017 (CONF-660308, pp 278-304) COMPARISON OF CERAMIC FUEL SYSTEMS FOR FAST BREEDER REACTOR APPLICATIONS. Wheelock, C. W. (Atomics International, Canoga Park, Calif.); Herbst, R. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.).

Ceramic fuels show an achievable potential for extremely economical fuel cycle costs for future fast reactors, as well as acceptable costs for large fast reactor plants which are built as soon as other system development requirements would allow. Development of U–Pu oxide fuels has progressed sufficiently to indicate that burnup levels of at least 50,000 Mwd/MT, and fuel cycle costs in the vicinity of 1.5 mills/kwh, are reasonable objectives for the first generation of fast power reactors. More advanced reactors, using carbide or nitride fuel with a sodium bond between the fuel and cladding show promise for burnup levels of 100,000 Mwd/Mt, doubling time of less than 10 years, specific inventory between 2 and 3 kg Pu/Mwe, and fuel cycle cost of 0.2 mill/kwh or less. (auth)

35018 (DP-MS-66-38) CRITICAL EXPERIMENTS WITH HIGHLY BURNED-UP PLUTONIUM IN D_2O. Olson, R. L.; Graves, W. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). June 1966. Contract AT(07-2)-1. 9p. (CONF-660606-4). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Nuclear Society Meeting, Denver.

The research program for producing ^{244}Cm in the Savannah River Production reactors is discussed. The feed material for the program is primarily ^{239}Pu. After the concentrated fuel was fabricated into fuel assemblies, it was used for critical experiments. A brief discussion of these experiments is presented. (M.O.W.)

35019 (EUR-2537.i) ANALISI DEGLI STUDI SULL'-ECONOMIA DEL CICLO U–Th. (Analysis of the Studies on the Economy of the U–Th Cycle). Scuricini, G. B.; Lavrencic, D.; Lumetti, A.; Venditti, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1966. 118p. Dep. mn.

A systematic description is given of all the techniques, either in use at the present or under development, which are aimed at the nuclear utilization of thorium, the account covering the successive stages in the process, such as ore extraction, element concentration, fuel fabrication irradiation in various types of reactor, reprocessing and refabrication. The economic factors governing each stage in the above-mentioned process are discussed. (auth)

35020 (EUR-2766.e) CHARACTERISTICS OF FAST NEUTRON POWER REACTORS. Beyens-Henry, M.-Th. (European Atomic Energy Community). Apr. 1966. 168p. Dep. mn.

A report is presented on the important features of 19 reactors or reactor projects complete with short bibliographies and diagrams of essential parts. (B.G.D.)

35021 (EURAEC–1577) STUDY OF A PRESTRESSED CONCRETE TANK FOR A 1000-Mw(e) BOILING WATER REACTOR. Quarterly Report No. 2, October–December 1965. (Societe d'Etudes Industrielles, Villejuif (France)). Jan. 1966. 62p. (EUR–2808). Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Work Performed Under United States–Euratom Joint Research and Development Program.

The results of the optimization described during the last period are given. To obtain these results, the following points were defined: external shape of the tanks, cooling of the ducts and definition of these ducts, and the work program. These results show that, for a given volume, a spherical shape is the most economical for the resistant casing only. Finally, the possibilities of small scale mock-up tests are set out, tests which would make it possible to verify the calculation hypotheses for the spherical tank. (auth)

35022 (GA–7130) EXPERIMENTAL BERYLLIUM OXIDE REACTOR PROGRAM. Quarterly Progress Report for the Period Ending March 31, 1966. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 29, 1966. Contract AT(04-3)-187. 29p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Phase I and II life-cycle tests of the prototype control rod drive mechanisms are discussed. Facility operations are also reported. (B.G.D.)

35023 (GAMD–6616) EXTENSION OF THORIUM PARTICLE LIFETIME FOR 330 Mw HTGR FUEL CYCLE STUDIES. Jaye, S.; Simon, W. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 6, 1966. Contract AT(04-3)-633. 16p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The standard fuel cycle considered for the 330-Mw(e) HTGR uses ^{235}U as the initial fissile material and thorium as the fertile material. An investigation was made on the fuel cycle performance when the thorium particles were re-used without chemical processing. Burnup calculations and fuel cycle cost considerations are discussed. (M.O.W.)

35024 (GEAP–5135) POST-IRRADIATION EXAMINATION OF EVESR MARK III SUPERHEAT FUEL (0.008-

INCH CLADDING FAILURE). Busboom, H. J.; Boyle, R. F.; Harling, G.; Hazel, V. E. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Mar. 1966. Contract AT(04-3)-189. 35p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The results from post-irradiation examination and analysis of the failed fuel element in assembly KB-41 of EVESR are reported. One fuel element was found defective, with a longitudinal cladding rupture about 5 in. long, located at the region of the highest heat flux. It was concluded that localized cladding temperatures of 1900°F experienced concurrently with an increased reactor power were sufficient to cause the initial failure. Continued exposure of the failed rod in the EVESR resulted in oxidation of UO_2, followed by swelling of the oxidized fuel portion. No evidence was found to indicate cladding thickness as a direct cause of the failure. Thus, it was recommended that the irradiation exposure of the 8-mil-clad fuel be continued to fulfill the original objectives for this experiment, which were to evaluate fuel element performance as a function of cladding thickness (i.e., fuel performance as a function of stress imposed upon the fuel cladding). The high cladding temperature in excess of 1900°F is assumed to be the cause of the cladding failure, but the initial cause of bringing about the high-temperature hot-spot is not known. (auth)

35025 (NP-16013) PROBLEMY OCHISTKI TYAZHELOI VODY IONOOBMENNYM METODOM. (Problems of Heavy Water Purification by Ion Exchange Method). Tia, Shw-yung; T'ung, Tien-chen; Ling, Fon-liang (Chinese Academy of Sciences, Peking. Inst. of Atomic Energy). 1964. 27p. Dep. mn.

The heavy water used as moderator and coolant in reactors must be continuously purified in order to avoid its radiolysis and corrosion of structural components. The batch distillation originally used for the purification of the Chinese heavy-water reactor was not sufficiently efficient; therefore, an ion-exchange method was developed. Organic and inorganic impurities, the activation of which presents the major problems, were eliminated from the cationite-anionite mixture. The factors investigated included: the height of the resin mixture in the columns, effect of the flow rate of the heavy water on the rate of deuterization of the ionites, determination of the level of deuterization and of the capacity of the deuterized ionites, and the quality of the purified heavy water. It was concluded that the ion-exchange method developed is well suited for the intended use; it is less expensive than the distillation method and it yields a product possessing a specific conductivity of 10^6 ohm^{-1} cm^{-1}, pH = 6.0 and total residue of 5 ppm. The radioactivity in operating areas was also less than in the case of distillation. (TTT)

35026 (ORNL-P-2178) THORIUM BREEDERS AND CONVERTERS: THEIR INFLUENCE ON FUEL CYCLE ECONOMICS AND FUEL UTILIZATION. Kasten, Paul R. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 20p. (CONF-660524-5). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From 2nd International Thorium Fuel Cycle Symposium, Gatlinburg, Tenn.

Cost evaluation studies were made for various reactor types. The basis for Th use in HTGR and MSBR systems is discussed. Fuel utilization and ^{233}U availability are discussed. (M.O.W.)

35027 (ORNL-tr-1226) REDUCED-SCALE RESISTANCE MODELS OF PRESTRESSED CONCRETE CONTAINMENTS FOR THE G2 AND G3 REACTORS. Beaujoint, N. Translated for Oak Ridge National Lab., Tenn., from RILEM (Reunion Int. Lab. Essais Rech. Mater. Construct.) Bull., 10: 25-34(1961). 21p. Dep. mn. JCL $2.60 fs, $0.83 mf.

Thermal energy is extracted from the G2 and G3 reactors by circulation of carbon dioxide gas at a pressure of 15 kg/cm^2. The chambers or containments subjected to this pressure and having a volume of 3,000 m^3, in which the reactors are installed, consist of prestressed concrete. These structures were studied by reduced-scale resistance models. The essential characteristics of the study, scale and number of models, their detailed description as well as those of the measuring equipment and the testing program are discussed. The results concerning the design of the study and the results of the experiments are examined. (B.G.D.)

35028 (ORNL-tr-1230) THE CIVIL ENGINEERING OF NUCLEAR POWER PLANTS OF THE TYPE WITH NATURAL URANIUM-GRAPHITE-CARBON DIOXIDE. Soulier, L. Translated for Oak Ridge National Lab., Tenn., from Tech. Mod., 57: 343-8(July 1965). 16p. Dep. mn. JCL $1.60 fs, $0.80 mf.

The dimensions of prestressed concrete pressure vessels for the EDF-3 plant of Chinon and the EDF-4 plant of Saint Laurent des Eaux are discussed. The original problems of foundation, handling, and control raised by the construction of these containments are described. The accuracy of location of ducts and supports in the reactor containment is discussed. (M.O.W.)

35029 DEMAND FOR NUCLEAR FUELS IN THE FEDERAL REPUBLIC OF GERMANY. Clauss, J. Atomkernenergie, 11: 278-82(July-Aug. 1966). (In German).

A simple method is used for the estimation of the uranium demand in the Federal Republic. This simple computation may be justified because the parameters and boundary conditions of a future nuclear reactor development are very unsafe at present. The nuclear energy is introduced only by economical reasons and one can also assume a random distributed set of various reactor types. (auth)

35030 THE CHAIN OF FEED PUMPS IN THE NUCLEAR POWER STATION GUNDREMMINGEN. Ratzeburg, Werner (Maschinenfabrik Halberg, Ludwigshafen, Ger.). Brennstoff-Waerme-Kraft, 18: 307-9(June 1966). (In German).

The pumping system for the feed water circuit in the nuclear power station of Gundremmingen must satisfy unusual requirements. The installation operates without a feed water collector. The problems resulting from series connection of the pumps are described. (auth)

35031 ROLE OF URANIUM IN ENERGY PRODUCTION. Cohen, Raymond L. (Canadian General Electric, Peterborough, Ont.). Can. Mining J., 87: 141-3(Apr. 1966).

A discussion is provided of heavy water reactors (HWR) as developed in Canada, and their impact on the mining industry with regard to the supply of uranium for fueling the reactors. Fuel fabrication is also considered. Estimates are made of how much uranium Canada and the rest of the world will need over the next 10 to 15 years. A cumulative total of 11,400 metric tons will be required by 1985. Compared to what Canada can produce, this is a small amount. For example, in the uranium boom several years ago, Canada was producing 45,000 metric tons annually; it is estimated that Canada could restart production at around 35,000 metric tons/year. (TCO)

35032 COMMISSIONING OF TOKAI NUCLEAR POWER STATION. [PART] I. Yuri, Tatsuo (Fuji Electric Manufacturing Co., Ltd., Japan). Fuji Jiho J., 39: 223-7 (Mar. 1966). (In Japanese).

The first nuclear power station in Japan, Tokai-mura, reached criticality on the 4th of May, 1965. The approach to criticality and physical experiments leading to full power are described. (TCO)

35033 EXPERIMENTAL STUDIES OF STEAM-WATER SEPARATOR FOR BOILING WATER REACTORS. Report No. 2. Tamai, Teruo; Ishii, Masanori (Ishikawajima-Heavy Industrial Co., Ltd., Tokyo). Ishikawajima-Harima Giho, 6: 130-42(Mar. 1966). (In Japanese).

Preliminary and high pressured experiments are reported. Air-water separation phenomena were observed in a transparent separator model made of acrylic resin. Separation length, pressure drop through a guide vane, and flow stability were measured, varying parameters such

as guide vane dimensions, void fraction, flow rate, and etc. The high pressure experiment was conducted using steam-water flow through a separator model at 60 kg/cm^2. Steam quality at various points was measured after varying flow rate and inlet steam quality. The results of the high pressure experiment showed that 100% dry steam was obtained at the exit of the pressure vessel with the axial steam-water separator. (auth)

35034 THE EFFECTIVE TEMPERATURE FOR NEUTRON ABSORPTION IN THE RESOLVED RESONANCES OF ^{238}U IN A 1/E SPECTRUM. Beynon, T. D. (Woolwich Polytechnic, London). J. Nucl. Energy: Pt. A and B, 20: 473-5(June 1966).

Calculations are presented giving a detailed picture of the concept of an effective temperature, used to replace a nonuniform temperature distribution in calculations of neutron flux in a cylindrical fuel rod and of the effects on the ^{238}U resonance absorption of Doppler broadening of the cross sections by a nonuniform temperature distribution, using a double-P_0 diffusion approximation to the transport equation. The graphite-moderated ^{238}U fuel rod in the CEGB Berkeley reactor is considered. The values of the effective temperature for the resolved resonances of ^{238}U are shown as a function of the resonance energy. (M.J.T.)

35035 REACTOR CONTAINMENT STRUCTURES ABROAD. Gluckmann, Alexis L. (Gibbs and Hill, Inc., New York). J. Power Div., Proc. Amer. Soc. Civil Engrs., 92: 59-76(Apr. 1966).

A nation-by-nation description is given, with diagrams, of containment design for nuclear power reactors. For the 11.5-Mw(e) BR-3 reactor at Mol, Belgium, which began producing power in 1961, the plant container is a vertical steel shell founded in a concrete slab surrounded by a steel sheetpile ring, one fourth of the container structure being below ground level. It is designed to resist the pressure build-up (45 psig). In 1966 in an early construction stage the Zorita project, a 160-Mw(e) nuclear power station in central Spain, utilizes a containment structure combining the best features of both steel-shell and reinforced-concrete construction, resulting in the optimum containment for this site. Because significant shielding was not required above the spring line of the dome, a simple hemispherical steel dome was chosen over reinforced concrete construction. The vapor container designed for a proposed nuclear power project in Japan and applicable to similar areas of high seismicity is presented. The containment consists of an inner concrete shield, a steel containment vessel, and a cylindrical outer concrete shield surrounding the steel container and extending to the same elevation as the top of the steel container. The vapor container for 272-Mw(e) SELNI project in Italy is nearly similar to the Japanese one. The principal difference is that for SELNI no seismic design is required, since the plant is located on the Po River, where seismic activity is negligible. The containment for reactors in Switzerland and similar densely populated areas with moderate to high seismic activity is identical with the container for Japan except that the outer shield is made continuous over the entire steel container by the addition of a concrete dome. Some requirements of reactor design to enable the structures to withstand earthquakes are considered in detail. (BBB)

35036 PRESTRESSED CONCRETE REACTOR VESSELS. Marsh, R. O.; Rockenhauser, W. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Mech. Eng., 88: No. 7, 34-41(July 1966).

A prestressed concrete structure for the 1000-Mw(e) high-temperature, gas-cooled reactor design study TARGET is discussed. The design philosophy and stress analysis for such a structure are described, as well as the use of models to predict structural behavior. (L.B.S.)

35037 DYNAMICAL EXPERIENCE WITH THE HEAVY WATER BOILING REACTOR (HBWR) AT HALDEN. Fishman, Y. (Therm-Atom SA, Lausanne, Switz.). Neue Tech., 8: 191-8(May 1966). (In French).

The dynamic behavior of the HBWR second charge was studied systematically by means of perturbation experiments. The input was in general either reactivity or steam flow, whereas the output was measured at a large number of different points, thanks to the various instrumented fuel assemblies available. The various types of perturbation used made it possible to determine why the system was unstable once a certain power level was reached, and helped in perfecting the mathematical model of the system's dynamics. (auth)

35038 SMALL POWER REACTORS. Nucl. Eng., 11: 374-6(May 1966).

The development of small reactors for ship propulsion is briefly discussed. The use of such reactors in land-based power stations is also considered. (D.C.W.)

35039 HEAVY WATER REACTORS. STATE OF PROGRESS AND DEVELOPMENT PROBLEMS. Finkelnburg, Wolfgang; Keller, Wolfgang; Preuss, Hans-Joachim (Siemens-Schuckertwerke AG, Erlangen, Ger.). Nucl. Eng., 11: 452-5(June 1966).

A status report on the development of heavy water reactors, including problems of fuel elements, cooling channels, reactor vessels, and charging machines, is presented. An appraisal of the prospects of D_2O-moderated reactors is also included. (B.G.D.)

35040 HEAVY WATER STEAM IN DIRECT CYCLE. MARVIKEN. Nilson, Ragnar (Aktiebolaget Atomenergi, Stockholm). Nucl. Eng., 11: 456-60(June 1966).

The general features of the Marviken heavy water moderated boiling reactor which uses heavy water as a coolant with the steam taken in direct cycle to the turbine are presented. The present status of the work is included. (B.G.D.)

35041 CANADIAN HWR. ECONOMIC ASSESSMENT. Holt, John O. Nucl. Eng., 11: 461-3(June 1966).

The economic assessment of the Canadian heavy water reactors is presented which includes physical plant, heavy water, fuel, operation and maintenance, and energy costs. (B.G.D.)

35042 CANADIAN HWR. FUEL. Pawliw, John. Nucl. Eng., 11: 464-6(June 1966).

The fuel for the Canadian heavy water reactors, which is a 19-element cluster of natural UO_2 pellets clad in Zircaloy and held together by end plates welded to the element ends, is discussed. Fuel handling is also discussed. (B.G.D.)

35043 UTILITY FUEL DILEMMA. Imai, Ryukichi (Japan Atomic Power Co., Tokyo). Nucl. Eng., 11: 546-7 (July 1966).

Fuel procurement policies for utilities are discussed. The status of uranium availability is also considered. (G.O.Y.)

35044 INTERNATIONAL COMPETITION IN THE NUCLEAR POWER INDUSTRY. Nucleonics, 24: No. 7, 41-53(July 1966).

The existing and emerging reactor-manufacturing and fuel-supply capabilities of eight nations which are among the most significant participants in the world market for nuclear power are described. The countries studied are Canada, Britain, France, Germany, Sweden, Switzerland, Italy, and Belgium. (J.F.P.)

35045 OUTLOOK BRIGHTENS FOR METALLIC PLUTONIUM FUELS. Kittel, J. H. (Argonne National Lab., Ill.). Nucleonics, 24: No. 7, 70-1(July 1966).

The performance of carbides, oxides, and metallic plutonium fuels is considered. The possible use of this fuel for fast breeder reactors is discussed, and a summary of data on high-burnup irradiations of fast-breeder plutonium fuels is given. (J.F.P.)

35046 ROLE OF ENERGY. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). S. Afr. Mining Eng. J., 77: 844-52(Apr. 15, 1966).

The world's future energy requirements and the role of nuclear energy in power development are considered. While nuclear plants are currently producing only a small percentage of America's total electrical energy, they

have recently become economically competitive with conventional plants in many areas of the country. Nuclear power reactors in use today are primarily pressurized water and boiling water reactors of the type which burn only 1% or less of their atomic fuel. While these systems are efficient and economic by today's nuclear standards, it is necessary to consider the total nuclear energy picture, planning and working toward the maximum efficient use of nuclear energy resources. At present, plans for making maximum use of uranium and thorium fuel reserves involve the development of advanced converter and breeder reactors. These reactors, in conjunction with fuel reprocessing systems, will allow use of a larger percentage of nuclear fuel. A nuclear fuel economy based on the use of breeder reactors, producing power and their own fuel, offers a way of stretching the world's supplies of uranium and thorium, which are vast but could be used up too rapidly without these new technologies. (TCO)

35047 OBJECTIVES OF REACTOR DEVELOPMENT AT SIEMENS. Finkelnburg, Wolfgang; Keller, Wolfgang. Siemens Rev., 33: 169-72(Mar. 1966).

The research and development program of the Siemens-Schuckert Reactor Development Department is described. This program is directed towards the development of economical power reactors, particularly for large power plants. Work has concentrated on heavy-water-moderated power reactors, and in the course of the development program two clear concepts were formed: A D_2O moderated and cooled pressure-vessel reactor whose prototype, the MZFR with 50 Mw(e) electrical power, is in operation at Karlsruhe. A CO_2-cooled pressure-tube reactor with an electric power output of 100 Mw(e). The latter type has been developed for the Gesellschaft zur Entwicklung der Atomkraft in Bayern (AKB) (Group for the Development of Nuclear Power in Bavaria) and its actual construction has already been decided upon. While for pressure-vessel reactors the emphasis is on the neutron economy, more importance is attached in the case of pressure-tube reactors to an increase in efficiency and to the attainment of conventional steam conditions, with all efforts also being aimed at simplification. Neutron leakage losses are high with the MZFR because of its small size of only 50 Mw. To reduce these losses to levels where an economic burnup can also be reached with natural uranium, vessel dimensions larger than 6 m are required for the ID. Tests are being made to solve this problem through the development of a prestressed concrete pressure vessel. This would also solve the problem of the present limit for pressure-vessel reactors, since D_2O reactors with prestressed concrete vessels could be built for an electric power output of up to 600 Mw(e). Work for the advanced development of the MZFR in the direction of a boiling superheated reactor is described. A major target is an increase in the power density which is still comparatively low for the 100-Mw reactor prototype. An increase in the coolant pressure from the present 60 kg/cm^2 abs to 100 to 120 kg/cm^2 abs and a better fuel subdivision from the present 19 to 37 rods could increase the power density by a factor of three. (BBB)

35048 THE WHITE-HOT DRAGON OF WINFRITH. A STEP TOWARDS HIGHER-TEMPERATURE REACTORS. Times Sci. Rev., No. 60, 10-12(Summer 1966).

The Dragon project is discussed. The development of this reactor, with emphasis on the fuel elements, the treatment of fission products which form around these fuel elements, and the helium coolant are considered. (J.F.P.)

35049 REVIEW OF CONTROL-ROD REQUIREMENTS FOR WATER-COOLED POWER REACTORS. Pashos, T. J. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 9: 8(June 1966).

35050 PERFORMANCE OF BORON-CONTAINING CONTROL RODS IN WATER-COOLED POWER REACTORS. Williamson, H. E. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 9: 9-10(June 1966).

35051 NEUTRON EXPOSURE OF THE PM-2A REACTOR VESSEL. Shure, K.; Oberg, Carl T. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc., 9: 55(June 1966).

35052 FUEL-ELEMENT DEVELOPMENT FOR THE GAS-COOLED FAST BREEDER REACTOR (GCFR). Campana, Robert J.; Siltanen, James N. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Trans. Amer. Nucl. Soc., 9: 63(June 1966).

35053 FAILURE OF BONUS REACTOR SUPERHEATER FUEL ASSEMBLY TRACED TO FAULTY WELD PRACTICE. Cunningham, J. E.; Long, E. L. Jr. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 65-6(June 1966).

35054 ONE-GROUP THREE-DIMENSIONAL ANALYSES OF ASSEMBLYWISE POWER AND EXPOSURE DISTRIBUTIONS IN YANKEE CORE I. Rosztoczy, Zoltan R.; Valerino, Michael F. (Combustion Engineering, Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc., 9: 135-6 (June 1966).

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35056 GAS-COOLED FAST-REACTOR DEVELOPMENT. Fortescue, Peter; Shanstrom, Raymond (General Atomics, San Diego). Trans. Amer. Nucl. Soc., 9: 213-14(June 1966).

35057 PIPED PARTICULATE FUEL SYSTEMS FOR FAST REACTORS. Chamberlain, Harry V.; Edwards, Jack J.; Kovacic, Evan C. (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc., 9: 214-15(June 1966).

35058 FEATURES OF SECOND-GENERATION SODIUM-COOLED FAST REACTORS. Amorosi, Alfred; Peters, Norman T. (Atomic Power Development Associates, Inc., Detroit). Trans. Amer. Nucl. Soc., 9: 215-16(June 1966).

35059 NUCLEAR REACTOR PLANT AVAILABILITY. Bierman, George F. (Metropolitan Edison Co., Reading, Pa.); Miller, Walter J. Trans. Amer. Nucl. Soc., 9: 218-19(June 1966).

35060 AVAILABILITY ASSURANCE FOR THE HEAVY-WATER ORGANIC-COOLED REACTOR (HWOCR). Murray, W. B. (Atomic International, San Diego). Trans. Amer. Nucl. Soc., 9: 219-20(June 1966).

35061 CANADIAN ON-POWER FUELING EXPERIENCE. McConnell, L. G. (Hydro Electric Power Commission of Ontario). Trans. Amer. Nucl. Soc., 9: 220(June 1966).

35062 SUMMARY OF THE 1965 PARTIAL INSPECTION OF THE EBWR VESSEL: CRACKING OF CLADDING. Balai, Nicholas; Jones Robert F. Jr.; Wimunc, Edward A.; Sutton, C. Roger (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 221(June 1966).

35063 EXAMINATION AND EVALUATION OF EXPERIMENTAL BOILING WATER REACTOR PRESSURE-VESSEL CLADDING. Sutton, C. Roger; Balai, Nicholas; Wimunc, Edward A.; Jones, Robert F. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 222(June 1966).

35064 REACTOR VESSEL SURVEILLANCE PROGRAM FOR THE PLUTONIUM RECYCLE EXPERIMENT. Jones, R. F.; Wimunc, E. A.; Balai, N.; Sutton, C. R. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 222-3(June 1966).

35065 MODERN TECHNIQUES USED IN DESIGN AND ANALYSIS OF NUCLEAR PRESSURE VESSELS. Davies, D. K. (Babcock and Wilcox Co., Alliance, Ohio). Trans. Amer. Nucl. Soc., 9: 223-4(June 1966).

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35067 CRITICAL ASSEMBLY MOCKUP OF THE SEFOR REACTOR IN ZPR-3. McVean, R. L. (Argonne National Lab., Idaho Falls, Idaho); Goin, R. W.; Weitzberg, A.; Leridon, A. Trans. Amer. Nucl. Soc., 9: 226(June 1966).

35068 ACTIVATION MEASUREMENTS OF THE DOPPLER EFFECT IN ^{238}U IN ZPR-3 ASSEMBLY 47 (SEFOR). Davey, William G.; Amundson, Paul I. (Argonne National Lab., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 9: 226-7(June 1966).

35069 ANALYSIS OF SEFOR MOCKUP IN ZPR-III. Reynolds, A. B.; Stewart, S. L. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc., 9: 227-8 (June 1966).

35070 EFFECT OF NIOBIUM CLAD ON LARGE FAST BREEDER PERFORMANCE. Cherry, B. H.; Kazi, A. H. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 9: 230-1(June 1966).

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35073 DEVELOPMENT OF A CONTROL-ROD WORTH MINIMIZER. Stanley, L.; (General Electric Co., San Jose, Calif.); Holland, L. K.; Holladay, R. L. Trans. Amer. Nucl. Soc., 9: 265(June 1966).

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35078 COMPARISON OF ANALYTICAL AND EXPERIMENTAL LIFETIME AND CONTROL ROD WORTHS FOR CVTR. Willoughby II, W. (Carolinas-Virginia Nuclear Power Association, Parr, S. C.); Nath, R. J.; Wyke, T. F. Trans. Amer. Nucl. Soc., 9: 276-7(June 1966).

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35080 POWER-DISTRIBUTION MEASUREMENTS AT SENN. Morgan, W. R. (General Electric Co., Pleasanton, Calif.); Barth, N. H. Trans. Amer. Nucl. Soc., 9: 278-9(June 1966).

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35084 COMPARISON OF MEASURED AND CALCULATED ISOTOPIC COMPOSITIONS AS A FUNCTION OF BURNUP IN A 1.5 PuO_2–UO_2, LIGHT-WATER-MODERATED FUEL ASSEMBLY. Tomonto, James R. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc., 9: 293-4(June 1966).

35085 FORMATION OF ^{238}Pu AND ^{232}U IN SLIGHTLY ENRICHED POWER REACTORS. Arnold, E. D. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 294-5(June 1966).

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35092 ECONOMICS OF INTEGRATED OPERATION OF NUCLEAR AND CONVENTIONAL PLANTS. Houser, H. G.; Nordman, D. A. (Westinghouse Electric Corp., East Pittsburgh, Pa.). New York, Inst. of Electrical and Electronics Engineers, 1966, Preprint No. 31 CP 66-44, 12p., $1.00. (CONF-660108-3). ORAU.

From IEEE Winter Power Meeting, New York.

Aspects of integrated nuclear and conventional power plants operation that are of importance to system planning are considered. It was found that the mixture of unit types generally increases the complexities of operation and planning. Three important aspects are discussed: the failure of mills/Kwhr to properly evaluate the relative economics of nuclear units and fossil-fuel units; the techniques of system simulation to provide a more realistic comparison; and the economic integration of nuclear units with other types, The use of nuclear power creates the need for an intermediate-type generation, and use of pumped-storage hydro and fossil-fuel steam units to supply this intermediate need is discussed. (B.L.M.)

35093 SUPERCRITICAL PRESSURE REACTOR TECHNOLOGY. Wright, J. H.; Tower, S. N.; Patterson, J. F.; Kellogg, H. B. (Westinghouse Electric Corp., Pittsburgh). 37p. (CONF-650602-85). ORAU. Gmelin, AED-CONF-65-125-124.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

The application of supercritical pressure fluid to the design of nuclear power plants is described, and the technical state-of-the-art for these applications is summarized. Supercritical fluid as a reactor coolant, its applications

and concepts, problems in development, and the status of the technology are considered. It is concluded that the supercritical fluid is proven to be reliable, effective, and economical in the electric utility industry, and has many applications. Also there is a limited but sound technology in the areas of heat transfer, corrosion and water chemistry, and fuel. (J.F.P.)

35094 NUCLEAR POWER PLANT EVALUATION. Chittenden, W. A. (Sargent and Lundy Engineers, Chicago). New York, Inst. of Electrical and Electronics Engineers, 1966, Preprint No. 31 CP 66-169, 21p., $1.00. (CONF-660108-2). ORAU.

From IEEE Winter Power Meeting, New York.

Some factors that must be considered when evaluating the addition of a nuclear unit to an already existing utility system are reviewed. Among these are cost, project schedules, regulatory procedures, siting considerations, and the plant's operating organization. (B.L.M.)

35095 ATOMIC ENERGY AND THE ELECTRIC UTILITIES IN THE WEST. Rengel, J. C. (Westinghouse Electric Corp., Pittsburgh). 26p. (CONF-651065-1). ORAU. Gmelin, AED-CONF-65-355-1.

From Society of Mechanical Engineers, Rocky Mountain Minerals Conference, Phoenix, Ariz.

Data are presented in the form of line and bar graphs, tables, and schematic representations to support a prediction that by 1980 50% of all power stations will be nuclear. (B.L.M.)

35096 CURRENT NUCLEAR POWER ECONOMICS. Andersen, R. K. (General Electric Co., San Jose, Calif.); Heagerty, J. J.; Marsh, W. D. New York, Inst. of Electrical and Electronics Engineers, 1966, Preprint No. 31 CP 66-164, 20p., $1.00. (CONF-660108-1). ORAU.

From IEEE Winter Power Meeting, New York.

Two new perspectives in evaluating nuclear power economics with respect to capacity and economics are applied to some questions relating to the application of nuclear power to existing electric systems. Some questions investigated are: 1. How does fossil plant investment cost influence the economic application of nuclear power? 2. What is the effect of fossil fuel price on the competitive position of nuclear power? 3. What are the effects of peaking generation on nuclear power economics? 4. What is the effect of system load factor? (B.L.M.)

35097 PRESSURE SUPPRESSING ARRANGEMENT FOR NUCLEAR REACTOR PLANT. Bond, George W. Jr.; Farbman, Gerald H.; Chinaglia, Leopoldo; Bloxam, Francis S. (to Westinghouse Electric Corp.). U. S. Patent 3,253,996. May 31, 1966. Filed Apr. 6, 1962.

A pressure suppressing arrangement for a plant employing a pressurized water reactor consists of an inner container such as the radiation shielding enclosing the reactor and associated heat exchangers, etc., and an outer container substantially surrounding and spaced from the inner container with a pool of liquid maintained between the containers. Ducts or tubes connect the interior of the inner container with the pool of liquid, and the discharge end of each tube is located below the liquid level in the pool to act as a submerged nozzle. In the case of an accident in which the primary reactor system ruptures within the inner container, the high temperature, high pressure fluid within the primary system escapes into the inner container. The fluid then flashes into vapor which fills the inner container and flows through the vent tubes into the relatively cool pool of liquid between the containers where the vapor is condensed. Non-condensable vapors are scrubbed and cooled as they bubble through the liquid in the pool and then enter a vapor space located above the liquid and within the outer container. The pressure then builds up until a balance of pressure is reached between the vapor space and the inner container. (B.L.M.)

35098 FUSED-SALT-FUELED, MOLTEN-METAL-COOLED POWER BREEDER REACTOR SYSTEM. Bettis, E. S. (to U. S. Atomic Energy Commission). U. S. Patent 3,262,856. July 26, 1966.

A fused-salt-fueled, molten-metal-cooled power breeder reactor is provided wherein molten metal is dropped vertically through fused-salt fuel to cool and circulate it. A fused-salt active region comprising vertical graphite columns penetrated by coolant channels floats on a reservoir of molten metal coolant. Fertile fused salt is disposed about the graphite columns to provide breeding. (AEC)

35099 METHOD OF CONTROLLING A NUCLEAR REACTOR PLANT AND APPARATUS THEREFOR. Kaegi, Jakob (to Sulzer Brothers Ltd.). U. S. Patent 3,253,994. May 31, 1966. Priority date Sept. 10, 1962, Switzerland.

A steam plant is provided that operates under variable load conditions and receives heat from a nuclear reactor by indirect heat transfer from the reactor coolant to the operating medium of the steam generator so that changes in the output of the plant, particularly increases of the output, are effected more quickly than in conventional plants. The plant is made up of a reactor, a steam generator, a steam consumer, and means for circulating a heat carrier through the reactor to act as coolant and through the generator to heat it. The preferred operating medium, water, circulates through the steam generator for vaporizing the water and through the steam consumer operating under variable load conditions. The heat generation in the reactor is coordinated directly and immediately with the load upon the plant upon each change of load, and the velocity of the heat carrier fluid is controlled in response to the heat generation in the reactor. The rate of feedwater supply to the steam generator is coordinated with the load on the plant at each change of the load. The steam generator of the plant is essentially used as a heat accumulator. (B.L.M.)

35100 BOILING WATER NUCLEAR REACTOR WITH IMPROVED VAPOR SEPARATING ARRANGEMENT. Weisman, Joel (to Westinghouse Electric Corp.). U. S. Patent 3,253,999. May 31, 1966. Filed Aug. 18, 1961.

A vapor-liquid separating arrangement is described for use with a boiling reactor in which the control rods are inserted vertically into the core from above. The separating apparatus is located above the core in the space necessitated by the control rods when withdrawn and may be installed in an already existing reactor of this type. The apparatus for separating the vapor from the vapor-liquid mixture formed in the reactor core comprises a first stage means for gross separation and a second stage coupled to the first stage for separating entrained liquid within the vapor separated by the first stage separation. The separated vapor from the second stage is collected and conducted to vapor utilizing means, and the separated liquid is collected from both stages and returned to the reactor. For the two stage separation, each two separators may serve a group of four fuel assemblies in the reactor core. An alternative arrangement is to include a plenum chamber above the core with a number of vapor-liquid separators communicating with the top of the plenum chamber and located above the chamber in a substantially upright position. The plenum chamber allows mixing of the vapor-liquid mixture and reduces the duty of the separators located above the fuel assemblies operating at the highest power level. (B.L.M.)

35101 THERMIONIC NUCLEAR REACTOR. Beckjord, Eric S.; Hobson, Robert R.; Fellows, Paul J. (to U. S. Atomic Energy Commission). U. S. Patent 3,259,766. July 5, 1966.

A thermionic energy conversion reactor which comprises a plurality of tubular fuel elements containing individual series connected thermionic converter cells arranged to form a cylindrical reactor core contoured within a sealed vessel having upper and lower "I" beam reinforced vessel heads, a manifold means for circulating liquid sodium through the core and vessel, and a movable neutron reflector disposed about the central portion of said vessel, effective for control of the reactivity of the reactor. Individual cesium vapor supply reservoirs are disposed in a head vessel portion heated by heat transfer through the

reinforced vessel head, and which are connected by fuel element vapor supply conduits to said fuel elements. (AEC)

Process Heat Reactors

Refer also to abstract 33374.

35102 (AEC-tr-6733) ANALYSIS OF THE TECHNICAL AND ECONOMIC INDICES OF NUCLEAR-POWERED DESALINATION PLANTS. Loginov, A. A.; Koryakin, Yu. I.; Chernyaev, V. A.; Zakharov, I. I.; Stoyushchev, B. A.; Suponev, A. D. Translated from Paper SWD/56 Presented at 1st International Symposium on Water Desalination, Washington, D. C., October 3–9, 1965. 53p. (CONF-651005-8). Dep. mn. CFSTI $3.00 cy, $0.50 mn. JCL $5.60 fs, $1.79 mf.

A mathematical analysis was made of the basic components of the total cost of fresh water in a dual-purpose plant with the use of vertical evaporators and flash evaporation units. (M.O.W.)

35103 WATER DESALTING SYSTEM STUDIES IN NUCLEAR ENGINEERING DESIGN CLASSES. Seale, Robert L. (Univ. of Arizona, Tucson). Trans. Amer. Nucl. Soc., 9: 210-11(June 1966).

35104 STRUCTURAL ENGINEERING ASPECTS OF A DUAL-PURPOSE DESALTING AND NUCLEAR POWER PLANT. Perri, Joseph G. (Burns and Roe, Inc., New York). 33p. (CONF-660112-1). ORAU. Gmelin, AED-CONF-66-007-1.

From American Society of Civil Engineers, Structural Engineering Conference, Miami Beach, Fla.

A conceptual presentation is made of a dual-purpose desalination and nuclear power plant, with the ultimate objective of bringing forward the structural engineering aspects of a modular vessel-structure assembly that, by its unusual features, illustrates effectively the great new developments associated with saline-water conversion. The material selected for this presentation embraces concepts and ideas representing the outcome of many months of fruitful researches on the subject of Controlled Flash Evaporators. One special concept for the Structure, the peculiarly shaped module which consists of an orthotropic plate system, is believed to be the appropriate selection for effectively conveying the idea of what can be accomplished with a traditional material conventionally limited to some specific engineering aspects. The modular concept as applied to boiler segments of limited magnitude and with pressurized elements independently and internally built is not new; its application, however, to evaporator stages of great magnitude is certainly an evolutionary product of the present engineering designs. This new application of the module will be of interest both to the engineers engaged in researches in the field of industrial design and the engineers dedicated to analogous structural configurations. Although no general theoretical derivations are given of the complete mathematical treatment of orthotropic plates, some general transformations of the constant coefficients of either the fourth or eighth order differential equations are given and adequate emphasis on fundamental principles associated with the use of the coefficients in the equations for pressurized orthotropic systems are discussed. In this respect, it is believed that the idea of a fictitious plate constitutes a contribution to the analysis of orthotropic plates. (auth)

35105 ECONOMICS OF SMALL NUCLEAR ELECTRIC-DESALINATION PLANTS. Baer, Robert L.; Solberg, Donald E. (Hittman Associates, Inc., Baltimore, Md.). 8p. (CONF-650602-82). ORAU. Gmelin, AED-CONF-65-125-112.

From American Nuclear Society 11th Annual Meeting, Gatlinburg, Tenn.

The economics of small (10 to 15 Mw(t)) nuclear plants which produce electricity and desalinate water were studied for the purpose of quantitatively determining the cost of electricity and water produced by small dual-purpose nuclear plants and to compare these to actual water and electricity prices for representative locations. It is concluded that there are many places where such plants are economically attractive compared to existing electric and water production units. These small dual-purpose plants are also as attractive as pilot plants because of their modest capital costs. (J.F.P.)

35106 NUCLEAR REACTOR AND INTEGRATED FUEL-BLANKET SYSTEM THEREFOR. Teitel, Robert J. (to Dow Chemical Co.). U. S. Patent 3,251,745. May 17, 1966. Filed Dec. 11, 1961.

A nuclear reactor, particularly a liquid metal fuel reactor, is provided that includes an integrated fuel-blanket processing system by means of which fissionable material formed in the blanket is transferred promptly and efficiently to the fuel system. The blanket is formed of a liquid metal, such as Bi or Bi-Pb alloy, containing a dispersion of a fertile material, such as Th, and is disposed around the reactor core or even within the core. Provision is made within the shielded region for continuously or periodically processing both the blanket and the fuel to remove fission products, for transferring the fissionable material to the fuel, or for recovering the breeder gain. Fused salt medium is used for the processing; all fluid metal and fused salt outlets and inlets to the processing vessels are controlled by freeze valves; and the transfer of liquids is by gravity flow or displacement by inert gas. (B.L.M.)

Production Reactors

35107 IRRADIATION OF HIGH-FLUX ISOTOPE REACTOR TARGET PROTOTYPES. Olsen, A. R.; Sease, J. D.; Richt, A. E.; Ullmann, J. W.; Clinton, S. D. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 66(June 1966).

35108 DATA PROCESSING APPLICATIONS TO A LARGE DUAL-PURPOSE NUCLEAR REACTOR. Leiby, David W.; Poor, C. F. (General Electric Co., Richland, Wash.). Trans. Amer. Nucl. Soc., 9: 263-4(June 1966).

Propulsion and Space

See also ENGINEERING — Space Propulsion

Refer also to abstract 35038.

35109 (BAW-1249(Vol.1)) NS SAVANNAH REPLACEMENT CONTROL ROD DRIVES SAFEGUARDS REPORT. VOLUME I. DESCRIPTION. (Borg-Warner Corp., Decatur, Ill. Marvel-Schebler Products Div.). Oct. 1962. Contract AT(30-1)-2478. 55p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

A detail description is presented of the replacement drive, vessel head, and support systems of the N.S. Savannah. (M.O.W.)

35110 (CNLM-5584(Vol.3)) SNAP-50/SPUR PUMP MOTOR DEVELOPMENT PROGRAM SUBCONTRACT. VOLUME III. MATERIALS DATA, AND MATERIALS AND PROCESS SPECIFICATIONS. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). Mar. 15, 1964. Contract AT(30-1)-2789. 93p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Materials data are presented for Haynes Alloy No. 25, beryllium oxide, lithium, potassium and NaK (78 wt.%K) as well as materials and process specifications for the SNAP-50/SPUR pump motor development program. (B.G.D.)

35111 (CNLM-6308) STATUS OF SNAP-50/SPUR PUMP DEVELOPMENT PROGRAM. Wood, G. M. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). May 27, 1965. Contract AT(30-1)-2789. 60p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The design and development progress of all pumps in both the reactor coolant and the power conversion systems of the SNAP-50/SPUR powerplant is reported. The specific areas reported on are film bearings, selection

of materials, hydraulic components, motors, integrated machines, and the back-up electromagnetic pump. (M.O.W.)

35112 (CONF-651026, pp 103-38) SNAP-8 DEVELOPMENT STATUS, SEPTEMBER 1965. Gordon, R. (Aerojet-General Corp., Azusa, Calif.); Slone, H. O. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center).

The status of the development of the SNAP-8 Program is summarized. The actual weights and measured performance of subsystems and components are listed. The development problems are described and the total amount of operating time and operating experience for each component are listed. The rated power loop (RPL-2) has operated for over 800 hours; and the PCS-1 (power conversion system 1), Phase I test operations, were completed. Results from these are included. (auth)

35113 (CONF-651026, pp 171-85) DEVELOPMENT OF A SNAP-8 PUMP FOR MERCURY SERVICE. Chalpin, E. S.; Pope, J. R.; Foss, C. L. (Aerojet-General Corp., Azusa, Calif.).

A mercury boiler feed-pump-motor assembly was designed, built, and tested for the SNAP-8, 35-kilowatt mercury Rankine-cycle, nuclear turboelectric space power system. The design incorporates, on a single shaft, a centrifugal pump and an ML-insulated, conventional 400 cps, 3-phase induction motor. The rotor is supported by angular-contact ball bearings of M-50 material. Polyphenyl ether (mix-4P3E) fluid is circulated through the motor housing, space-seal heat exchanger, and bearings for lubrication and cooling. A visco pump and a molecular pump are used in series to minimize the loss of mercury to space. A slinger and a molecular pump in series are used to reduce leakage of mix-4P3E to space and to preclude leakage of the lubricant to the motor cavity during operation. Carbon-face static seals are incorporated to minimize leakage of the process fluids while the assembly was shut down, and to preclude interchange of the fluids. A liftoff device is incorporated to lift the carbon seals from the rotating shaft during operation. A jet-pump is incorporated upstream of the centrifugal pump to provide positive suction head to the centrifugal impeller at very-low-flow start conditions. The pump-motor assembly is all welded for positive sealing. Over 1,000 hours of testing have established the design performance and integrity of the pump-motor assembly. Basic problems resolved were a space-seal system to minimize loss of process fluids to space, special bearings designed for 10,000-hr operation, an electrical insulation of polyimide (ML) material for resistance to mix-4P3E at an operating temperature of 250°F, and resistance to a radiation environment in space. Instrumentation for accurately measuring NPSH was also a basic problem. (auth)

35114 (CONF-651026, pp 186-200) DESIGN AND DEVELOPMENT OF PUMPS FOR HIGH-TEMPERATURE NaK SERVICE. Chalpin, E. S.; Colker, C. P.; Foss, C. L. (Aerojet-General Corp., Azusa, Calif.).

The SNAP-8 35-kilowatt nuclear turboelectric space power system uses a sodium-potassium alloy (eutectic NaK-78) to transmit heat to and from the mercury Rankine-cycle loop. Two pump-motor assemblies of like configuration were designed, built, and tested for service in the NaK heat-input loop and in the heat-rejection loop. The units are self-contained, all-welded, and hermetically sealed. They incorporate on a single shaft a centrifugal pump, a hermetically-sealed (canned) drive motor, an internal NaK lubricant-coolant circulating pump, and NaK-lubricated bearings. Included with the pump-motor assembly are a heat exchanger-cold trap combination utilizing a polyphenyl ether fluid as the coolant, a NaK economizer, and a NaK filter. The NaK lubricant-coolant circuit is independent of the process pumping circuit, attained through the use of a shaft-to-housing annulus. No static or dynamic seals are used. The bearings are of the tilting-pad journal and thrust design. Over 1800 hours of testing have established the design performance and integrity of the pump-motor assembly. Basic problems resolved were positive containment of NaK without leakage, operable bearings utilizing NaK as the lubricant-coolant, and a motor which is operable in a space and radiation environment. Plots of H-Q, efficiency, power, and NPSH are presented. A comparison to show correlation of performance data obtained using water and NaK is also presented. (auth)

35115 (CONF-651026, pp 285-306) DEVELOPMENT OF THE SNAP-8 BOILER. Kreeger, A. H.; Hodgson, J. N.; Sellers, A. J. (Aerojet-General Corp., Azusa, Calif.).

Development of the mercury boiler for the SNAP-8 system is one of the major tasks of the SNAP-8 program. The 1500 hours of testing accumulated on two of the first-generation boilers has permitted detailed evaluation of performance under various operating conditions. Initial tests showed that the boiler performed at only 40% of its thermal design capacity. Even after 600 hours of operation, the boiler could not deliver its rated superheat at design flow rate. Trace amounts of rubidium were added to the mercury. The boiler immediately responded to the additive, reaching its design thermal capacity. A second unit of the same design reached rated thermal output in 26 hours without the use of an additive. This time-dependent conditioning process is the major problem in boiler development. Scaled tests on a single-tube are reported to support a new boiler design which should minimize the conditioning problem. Increased liquid velocity is shown to condition a poorly performing boiler. These scaled tests also provided empirical correlations of heat transfer and pressure drop from which other designs may be extrapolated. (auth)

35116 (CONF-651026, pp 415-76) MRPC (SNAP 2) TURBOALTERNATOR MODEL CRU V. Biering, R. C.; Decker, O. Sr. (TRW Inc., Cleveland, Ohio).

The Mercury Rankine Power Conversion Program (MRPCP) formerly called SNAP 2 is being conducted at TRW Inc. to develop the technology required to design a turboalternator for space application. The turboalternator (CRU V) has provided much useful information for this objective, demonstrating to the extent possible the feasibility of a dynamic Mercury Rankine System operating in space. The CRU V design details are presented along with the results of the development program to date. (auth)

35117 (CONF-651026, pp 477-97) DESIGN AND DEVELOPMENT OF A TURBINE-ALTERNATOR ASSEMBLY FOR THE SNAP-8 SYSTEM. Cherry, M. G.; Oiye, G. (Aerojet-General Corp., Azusa, Calif.).

The need for a reliable turbine-alternator assembly arose when the potential methods of electrical power generation were considered for the SNAP-8 system. The turbine-alternator for this system was designed to produce 51.6 kw at the alternator terminals at an overall efficiency of 49.5% and to do so reliably and unattended for at least 10,000 hours. Superheated mercury vapor is the working fluid. The turbine-alternator assembly (TAA) consists of two separate but integrated units: the turbine assembly, and the alternator assembly. Polyphenyl ether (mix-4P3E) is supplied to cool the alternator stator and lubricate the bearings. When two fluids such as mercury vapor and polyphenyl ether are in contact with the same shaft, there is a distinct possibility that they will intermix. To prevent this in the SNAP-8 turbine-alternator assembly, a low-leakage seal to space was designed. This seal, situated between the turbine and support bearings, consists of a visco pump, a slinger pump, and a molecular pump in series. The complete turbine alternator assembly was designed within the "state of the art" to ensure high reliability. Where conflicts of reliability and performance occurred, unless the performance gains were substantial, reliability overruled. Two units were tested. The first unit was tested using nitrogen gas as the working fluid for the turbine. The purpose of these tests was primarily to check the functional operation of the unit at the design speed, and to obtain measurements of the bearing and slinger losses. The second unit has recently completed some 830 hr of operation at design and off-design conditions in mercury vapor. (auth)

35118 (CONF-651026, pp 582-640) MERCURY RANKINE (SNAP 2) RADIATOR CONDENSER DEVELOPMENT EXPERIENCE. Heiskala, V. H.; Smith, R. C.; Elliott,

E. A.; Lancet, R. T. (Atomics International, Canoga Park, Calif.).

Radiator condenser (RC) concepts which were designed, fabricated, and tested at Atomics International for the Mercury Rankine Program (SNAP 2) are presented. These include conical steel fin-steel tube honeycomb, conical aluminum fin-steel tube, and flat copper fin-steel tube radiator condensers. The emissivity coating development program, which was carried on concurrent to the RC development program, is outlined along with applicable coating test experience. Thermal and structural component testing and prototype system mockup test experience (PSM-1, PSM-3) are summarized. Steady-state RC heat transfer, pressure drop, and stability characteristics are predicted and compared to experimental data resulting from system testing with a horizontal RC and from testing in a single tube condensing rig. One-dimensional and two-dimensional heat transfer models of the RC are shown and the relative accuracy of the two models is compared. The results calculated from these heat transfer models are shown to be in good agreement with experimental data. The pressure drop model, which is based on the fog flow theory of Koestel but uses the two-phase flow friction factor correlation of Baroczy and Sanders (Model 2), is recommended for mercury condensing pressure drop calculations. Results calculated with this model are compared to experimental data from testing both at Atomics International and other sources; the comparison is shown to be fair. Types of instabilities which can occur during RC operation are discussed along with criteria for determining the limits of stability. Results are discussed as a photographic study of instabilities encountered in a glass tube in a single tube condensing rig. (auth)

35119 (CONF-651026, pp 641-68) DESIGN AND DEVELOPMENT OF THE SNAP-8 MULTITUBE CONDENSER. Kreeger, A. H.; Hodgson, J. N. (Aerojet-General Corp., Azusa, Calif.).

The design, development, and testing of the condenser for this SNAP-8 Electrical Generating System marks one of the major accomplishments of the SNAP-8 Program. The SNAP-8 system condenser is a counterflow tube-in-shell heat exchanger. It consists of 73 tapered tubes surrounded by a tapered shell. Mercury condenses inside the tubes. The shell-side fluid is a sodium-potassium eutectic mixture (NaK) which flows through the condenser as part of the heat-rejection system. The tube configuration is designed to permit operation with a stable liquid-vapor interface in a zero-gravity environment. The condenser development incorporated detailed analytical investigations of heat-transfer modes. These analyses extended from literature surveys to configuration studies conducted at Aerojet. The condenser size and number of tubes is influenced by the mercury inlet velocity, condensing mercury heat-transfer coefficient, and the diameter and spacing of the tubes. The existing condenser is the result of this parametric analysis. The SNAP-8 condenser was tested under conditions identical to its space application with the exception of zero-g. The objectives of the test program were to investigate the relationships between flow rates, temperatures, condenser inventory, and condensing pressure. A concurrent NASA-conducted program using a SNAP-8 condenser tube (MECA Project) provides additional test data for comparison. The condenser was found to comply to the SNAP-8 system requirements. (auth)

35120 (LA-3393) INTEGRAL GAMMA AND NEUTRON MEASUREMENTS ON THE PHOEBUS 1A-321 REACTOR. Worman, F. C. V.; Ahlquist, A. J. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Jan. 1966. Contract W-7405-eng-36. 52p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

Leakage radiation from Phoebus 1A-321 was evaluated. Integral measurements of gamma dose, neutron flux, and neutron dose were made on all experimental plans that involved criticality. A total of 69 stations were implemented in three experimental plans. Gamma doses in air during a full-power run ranged from 1.15×10^6 rads at 60 feet to 2.50×10^1 rads at 2,100 feet. Thermal neutron fluxes declined from 96.5% of the total fast neutron flux at 60 feet to 28% at 3,000 feet. Included are additional gamma results obtained from film badges placed on arcs around the reactor with radii ranging from 1,000 to 128,000 feet. (auth)

35121 (LA-3428) ON POWER TRANSIENTS IN PROPULSION REACTORS INDUCED BY WATER INJECTION. Chezem, Curtis G. (Los Alamos Scientific Lab., Univ. of California, N. Mex.). Dec. 1965. Contract W-7405-eng-36. 52p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

The question of the magnitude of the nuclear transient resulting from the inflow of water into the core of a NERVA-type reactor was considered. The core is assumed to be an array of small circular holes penetrating a thick solid. Initially water is allowed to enter the array, and the water–air interface is advanced through the channels in small steps, during which steady-state conditions of flow, heat conduction and nuclear radiation heating are assumed to exist. Reactivity is added to the core as an empirical function of water penetration, and the core power time profile is traced. (auth)

35122 (N-66-13124) DESIGN SPECIFICATION (ENGINE, ROCKET, NUCLEAR) FOR XE-1, NERVA PROGRAM. Landesberg, E. (Aerojet-General Corp., Sacramento, Calif.). Mar. 1965. Contract SNP-1. 38p. (NASA-CR-68622; AGC-90016; RN-DR-0020). CFSTI $2.00 cy, $0.50 mn.

Design specifications are given for the hot-bleed, shielded, XE-1 configuration of the ground test experimental version of the NERVA engine series. This engine is suitable for static firing tests (300 sec max) with the engine oriented in a nozzle-down position. Specifications are given for the following major subsystems: reactor and thrust chamber assemblies; external shield; and propellant feed, emergency cooldown, pneumatic, control, and diagnostic instrumention systems. (STAR)

35123 (N-66-13125) [STUDIES OF THE NERVA PROGRAM]. Quarterly Report No. 3, April–June 1965. (Aerojet-General Corp., Sacramento, Calif.). Sept. 30, 1965. Contract SNP-1. 298p. (NASA-CR-68623; RN-Q-0036). CFSTI $6.00 cy, $1.50 mn.

Progress in the NERVA engine development program and its associated tasks is reported. The material is presented in a precise summary manner; and includes developments in the following areas: engine system, propellant feed system, reactor system integration, thrust chamber assembly, engine controls, systems analysis, radiation effects program, remote handling equipment, ground support equipment, instrumentation, ground operations safety, product assurance, non-fuel materials, and exhaust system. (STAR)

35124 (N-66-16525) FEASIBILITY STUDY OF DIRECT-FLOW GAS CORE REACTOR SYSTEM. Hunter, Henry M.; Degarabedian, P. (TRW Systems, Redondo Beach, Calif.). Jan. 31, 1966. Contract NASw-1166. 316p. (NASA-CR-70013; STL-4393-6003-RO-000). CFSTI $7.00 cy, $1.75 mn.

The feasibility of a direct-flow gas-core propulsion reactor concept employing a single axial gaseous fuel jet surrounded by a coaxial stream of gaseous hydrogen propellant is investigated. The proposed concept avoids the problems of fuel retention associated with more complex flow fields by collecting the single fuel stream in a scoop located at the discharge end of the reactor where it is cooled, condensed to the liquid phase, and recirculated. The study is primarily concerned with the feasibility of the scoop that collects the hot gaseous fuel at the reactor discharge and, consequently, operates in a severe thermal environment. Computer programs were used to determine the heat loads and mixing between fuel and propellant streams. Various advanced cooling techniques were used to determine the feasibility of cooling the fuel scoop. The propulsion system was analyzed in sufficient depth to uncover critical problem areas and to establish reasonable design and performance conditions for evaluation of system feasibility. (auth)

35125 (NAA-SR-Memo-11865) SNAP 10A EXPANSION COMPENSATOR TESTS SIMULATING FS-3 SYSTEM

CONDITIONS. Stone, L. R. (Atomics International, Canoga Park, Calif.). Mar. 1, 1966. Contract AT-11-1-GEN-8. 41p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Two SNAP 10A Secondary Containment Expansion Compensator Units (ECU), S/N's 022 and 023, were subjected to ten temperature-deflection cycles and up to 100 hours of steady state operation at 775°F to determine if ECU's, which were on long term endurance operation, would withstand additional operation at increased temperatures and bellows deflections. The tests were consecutively designed to simulate the operating conditions which are proposed to increase the mean system temperature of the FS-3 nuclear ground test system. The initial operating conditions were to deflect the bellows to a position where a stress level of approximately 90,000 psi was developed at a temperature of 700°F. The cycle procedure was to increase the bellows deflection 0.21 inches, equivalent to an 8.5 cu in. volume displacement per ECU due to a 1000°F mean system temperature increase above 700°F, and simultaneously increase the ECU temperature to 775°F. Both ECU's satisfactorily completed the test program without any significant degradation in ECU performance. Since the test operating conditions developed bellows stresses which were a minimum of 122 percent greater than any anticipated system ECU stress levels, there should be no significant ECU performance changes resulting from the proposed FS-3 system operational changes. (auth)

35126 (NAA-SR-Memo-11914) SNAP 10A COMPONENT QUALIFICATION PROGRAM FINAL REPORT. Ohlenkamp, R. M.; Wade, B. R.; Sexton, I. B. (Atomics International, Canoga Park, Calif.). May 6, 1966. Contract AT(11-1)-Gen-8. 108p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

The SNAP 10A component qualification test program was successfully conducted over a three-year period in conjunction with extensive development testing plus the qualification and demonstration testing of flight systems. During the past 1½ years sufficient endurance testing was accumulated to enable authoritative reliability predictions for operating periods of up to 1 year in orbit. The component testing has been mainly failure-free, although some components were redesigned as a result of early failures. The qualification program was directed at the determination of flight suitability insofar as environments and major performance objectives are concerned. The objective was to determine the suitability of each component prior to the commitment of the FS-1 and FSM-4 qualification systems and the flight systems to their respective test programs. This primary objective was met except in the case of the first expansion compensator design which caused failure of the FS-1 during system acceptance test and necessitated its replacement with the FS-3 system. The significant success of the ground test qualification system and of the flight test demonstration is due in large part to the conduct of the component qualification program. Thus, important design changes were incorporated early in the project's history, and sufficient familiarity was obtained such that very few human errors or oversights crept into the vital system test operations. (auth)

35127 (NAA-SR-Memo-11927) ANALYSIS OF THE SNAP-10A FSM-4 PRESTARTUP TESTS. Boyle, T. J.; Parker, G. H.; Shaw, H. K. (Atomics International, Canoga Park, Calif.). Apr. 20, 1966. Contract AT(11-1)-Gen-8. 26p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The SNAP 10A FSM-4 prestartup orbital tests are evaluated by thermal analysis of the test data. The effects of gravitational forces on the simulated space conditions are assessed. The thermal performance of the ejectable heat shield and its thermal coupling to the NaK system is discussed. (auth)

35128 (NP-16129) NUCLEAR SPACE MISSIONS: A SELECTED BIBLIOGRAPHY. Special Literature Survey No. 9. Velin, R. R.; Magnolia, L. R. (comps.) (TRW Systems, Redondo Beach, Calif.). Sept. 7, 1965. 23p.

A compilation of 220 articles dealing with all aspects of nuclear space missions is presented. (M.O.W.)

35129 (WANL-TME-1153) EFFECTIVENESS OF VERTICAL SHIELDS IN A CLUSTER OF THREE NERVA II MODULES. Ricks, L. O. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Apr. 1965. Contract SNP-1. 44p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The two locations for shields considered here are in the regions between the top shadow shield and reflector and around the reflector. Only one material, lithium hydride-steel, was considered for the top shield, three materials were considered for the extension and side shields. These three materials were lead, steel, and lithium hydride-steel. (M.O.W.)

35130 (N-66-14377) STUDY OF A NUCLEAR ELECTRIC GENERATOR FOR SPACE. (Commissariat a l'Energie Atomique, Paris (France)). Translation of Etude d'un Generateur Electrique Nucleaire Spatial. 46p. (NASA-TT-F-9806). CFSTI $2.00 cy, $0.50 mn.

The results of an exploratory study on selecting a nuclear electric generator for space applications are presented. Discussions are included on the electric power needs of space vehicles, the choice of the energy conversion process, the choice of the temperature range and materials, the reactor choice, control and starting problems, radiation protection, comparisons between the thermal and fast reactor, and examining the problem for different power levels. (STAR)

35131 IN-CORE TEMPERATURE CONTROL OF NRX REACTORS. Elmiger, R. A. (Westinghouse Astronuclear Lab., Pittsburgh). J. Spacecraft Rockets, 3: 262-3(Feb. 1966).

The design and performance of an in-core temperature control system for the NRX reactors are discussed. (B.G.D.)

35132 NUCLEAR ENGINE CLUSTERING CONSIDERATIONS. Langley, Robert W.; Woyski, Jan S. (Douglas Aircraft Co. Inc., Santa Monica, Calif.). J. Spacecraft Rockets, 3: 912-18(June 1966).

Some considerations involved in the clustering of solid-core nuclear engines were examined parametrically in order to determine their importance and to indicate the effect of system tradeoffs on vehicle performance. These include neutronic coupling effects, structural requirements, shielding, and reliability. A potentially important consideration is the propulsion system reliability. To satisfy typical propulsion reliability requirements for a manned mission, it is shown that clustering with engine-out capability may be effective in relaxing the reliability constraints of the individual engines. For example, for a Mars landing mission, engine-out capability on the first three stages results in an initial weight-out-of-orbit penalty of 20%, but reduces the individual engine reliability requirements from 0.99 to 0.92. This can represent a significant difference in engine development effort. (auth)

35133 SHIP-PROPULSION REACTORS, STATUS AND PERSPECTIVE. von zur Muehlen, M. (Schiffbau und Schiffahrt mbH, Hamburg). Kerntechnik, 8: 278-80(June 1966). (In German).

The present development of ship propulsion reactors is outlined, and the national aims of various countries are indicated. (J.S.R.)

35134 FABRICATION AND PROPERTIES OF COPPER-BORON CARBIDE CONTROL MATERIAL FOR PHOEBUS II REACTOR. Sheinberg, H.; Keil, R. W. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc., 9: 11-12(June 1966).

35135 LIMITERS IN NERVA REACTOR CONTROL. Hohmann, Garold L.; Walsh, Joseph M.; Honka, Eric K. (Westinghouse Astronuclear Lab., Pittsburgh). Trans. Amer. Nucl. Soc., 9: 152(June 1966).

35136 EXPERIMENTAL AND ANALYTICAL RESULTS ON THE TUNGSTEN WATER-MODERATED NUCLEAR ROCKET CRITICAL ASSEMBLY. Bardes, R. G.; Bohren, C. F.; Cohen, S. C.; Gillette, E. M.; Lovallo, J. M.; Moore, R. A.; Peak, R. A. (General Atomics, San Diego). Trans. Amer. Nucl. Soc., 9: 152-3(June 1966).

35137 NUCLEAR HEATING CALCULATIONS IN A FAST-SPECTRUM REFRACTORY-METAL REACTOR ASSEMBLY. Edwards, W. E.; MacDonald, J. E.; Robertson, C. S. Jr. (General Electric Co., Cincinnati). Trans. Amer. Nucl. Soc., 9: 154(June 1966).

35138 ZIRCONIUM-HYDRIDE FUEL BEHAVIOR IN THE SNAPTRAN TRANSIENT TESTS. Kessler, W. E.; Brockett, G. F.; Bingham, G. E. (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 9: 155 (June 1966).

35139 PRELIMINARY ANALYSES OF SNAPTRAN-2 DATA. Moss, L. I.; Jackson, J. F.; Rhoades, W. A.; Green, W. B.; Johnson, R. P.; Dye, F. C. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 155-7(June 1966).

35140 FAULT TREE ANALYSIS FOR SNAP REACTOR DISPOSAL SYSTEMS. Willis, C. A.; Carlson, W. J. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 159-61(June 1966).

35141 RESULTS OF ONE-YEAR OPERATION ON THE FS-3 SNAP-10 SYSTEM. Sturtevant, W. C.; Miner, S. (Atomic International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 162-3(June 1966).

35142 INSTRUMENTATION AND CONTROL OF THE SNAP-8 REACTOR. Steele III, Oliver P.; Kellogg, Larry G. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc., 9: 163-4(June 1966).

35143 ANALOG COMPUTER STUDY OF THERMIONIC-REACTOR POWER-PLANT TRANSIENTS. Gronroos, Henrik (California Inst. of Tech., Pasadena). Trans. Amer. Nucl. Soc., 9: 165-6(June 1966).

35144 ISOTHERMAL TEMPERATURE COEFFICIENT OF THE TUNGSTEN WATER-MODERATED ROCKET CRITICAL ASSEMBLY. Cohen, S. C.; Bardes, R. G.; Peak, J. C. (General Atomic, San Diego). Trans. Amer. Nucl. Soc., 9: 188-9(June 1966).

Research and Test Reactors

35145 (AECL-2563) DECAY OF THE GAMMA RAY DOSE RATE FOLLOWING A SHUTDOWN IN THE NRX REACTOR. Boyd, A. W.; Connor, H. W. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1966. 12p. Dep. mn. AECL $0.50.

Measurements were made of the decay of the γ-ray dose rate from one second to several days after shutdown using graphite-CO_2 ion chambers. The results were summarized. (B.G.D.)

35146 (AERE-R-4205) FAST-FLUX MEASUREMENTS IN ZERO-ENERGY REACTORS. Trebilcock, R. J. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1962. 12p. Dep. mn.

A number of high-power research reactors have zero-energy counterparts, and it is desirable to use these as far as possible for flux measurements on experimental rigs. Measurement of fast flux in high-power reactors may be accomplished with threshold detectors such as ^{32}S or ^{58}Ni, but these are not sufficiently sensitive for measurements near the core in zero-energy reactors, where the large samples necessary would cause severe flux perturbation. The use of ^{103}Rh and ^{31}P for fast-flux measurements is described, and comparisons are given which enable sulphur and nickel activations to be predicted from measurements with phosphorus and rhodium. An appendix gives experimental details on the use of rhodium and phosphorus. (auth)

35147 (CEX-64-7) NEUTRON AND GAMMA-RAY LEAKAGE FROM THE ICHIBAN CRITICAL ASSEMBLY. Thorngate, J. H.; Johnson, D. R.; Perdue, P. T. (Oak Ridge National Lab., Tenn.). Dec. 1965. Contract W-7405-eng-26. 57p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

This experiment is a continuation of studies begun in 1956 to determine the radiation doses received by the survivors of the Hiroshima and Nagasaki nuclear detonations. The "Ichiban" critical assembly was designed and constructed at Los Alamos Scientific Laboratory to provide a simulant for the Hiroshima bomb with respect to radiation "leakage" and spectrum. It was operated at steady-state power levels while neutron and gamma-ray dose measurements were made. The results were corrected for room scattering and normalized to dose per fission. The first collision neutron dose measured at a distance of 9.5 meters was $7.7 \pm 0.3 \times 10^{-17}$ tissue rads per fission. Coupled with the mean dose per neutron of 1.14×10^{-9} rad/neutron/cm^2, this measurement represented a total fast neutron leakage of 0.77 ± 0.03 neutrons per fission. (auth)

35148 (IDO-17179) SPERT PROJECT. Quarterly Technical Report, October-December 1965. Crocker, J. G. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). June 1966. Contract AT(10-1)-205. 67p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

An experimental program designed to investigate the kinetic behavior of low enrichment UO_2 cores under typical pressurized water reactor conditions is discussed. Experimental results of static nuclear characteristic measurements on the Capsule Driver Core are presented. The CDC fiducial transient and capsule experiments are outlined, as well as out-of-pile explosion tests being conducted to aid in the development of capsules and instrumentation for use in explosive environments. The Power Burst Facility Testing Program is also discussed. (B.G.D.)

35149 (KR-103) MEASUREMENT OF THE SPATIAL VARIATION OF THE THERMAL NEUTRON ENERGY SPECTRUM IN REACTOR CELLS. Smit, J. (Institutt for Atomenergi, Kjeller (Norway)). Apr. 1966. 15p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The spatial variation of the thermal neutron spectrum is measured indirectly in terms of a spectrum index SI, defined as the ratio of the ^{176}Lu: ^{164}Dy activation ratio in experiment to ^{176}Lu: ^{164}Dy activation ratio in thermal spectrum of 20°C. These measurements were carried out in the zero-power reactor NORA in a mixture of heavy and light water (45% H_2O) and in four light water lattices with the lattice pitch and the moderator temperature as parameters. The experimental results are compared with calculations performed using the K-7 THERMOS code with the following three energy transfer models: the free gas model of Brown and St. John, Nelkin's model, and an anisotropic version of Nelkin's model due to Koppel and Young. The latter model gives in almost all cases satisfactory agreement with the experimental results. (auth)

35150 (NAA-SR-Memo-10557(Pt.1)(Rev.)) MONTE CARLO EVALUATION OF COLLIMATOR EFFICIENCY. PART 1: DESCRIPTION OF THE CLUB COMPUTER CODE. Green, W. B.; Hubner, R. S. (Atomics International, Canoga Park, Calif.). Nov. 4, 1965. Contract AT(11-1)-Gen-8. 34p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The CLUB code is a Monte Carlo computer program designed to assist in the evaluation of neutron collimator efficiency. The theory on which the code is based is described, along with the code input and output. Several errors contained in the original document are corrected. (auth)

35151 (ORNL-TM-1488) EXPERIMENTAL DETERMINATION OF SAFE HANDLING PROCEDURES FOR HIGH FLUX ISOTOPE REACTOR FUEL ELEMENTS OUTSIDE THE REACTOR. Raffety, S. J.; Thomas, J. T. (Oak Ridge National Lab., Tenn.). July 1966. Contract W-7405-eng-26. 23p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A series of experiments has been performed with the fuel element fabricated for the third High Flux Isotope Reactor Critical Experiment (HFIRCE-3) to establish safe conditions for the routine handling, shipping, and storage of HFIR fuel outside the reactor. The negative reactivity, or the shutdown margin, of the HFIRCE-3 fuel element when submerged in an effectively infinite water reflector was found to be 1.15 ± 0.09 dollars. The shutdown margin with a storage post in the target region was

8.57 ± 0.32 dollars, and the shutdown margin with a 0.026-in.-thick cadmium sheet wrapped around the element leaving a ¼ in. water gap was about 16 dollars. The effect of displacing water from the target region was studied by placing Styrofoam cylinders in the submerged element. It was found, for example, that the submerged HFIRCE-3 element would be critical if 15% of the water was displaced from the target region and that the maximum increase in reactivity, about 4 dollars, would be produced by displacing approximately 69% of the water from the target region. Displacing water inside the storage post reduced the shutdown margin of this system to a minimum of 3 dollars when all of the water had been displaced from the post. The negative reactivity value of various stainless steel strips, with and without boron, which could be inserted between the fuel plates of the element was determined and is reported in tabular and graphical form. The effect of steel or combinations of steel and lead or steel and concrete as reflectors displacing water adjacent to the submerged element was also studied. Reflectors of steel or lead less than 3.5 in. thick reduced the reactivity of the system but greater thicknesses increased the reactivity with lead producing the greater increase. The HFIRCE-2 fuel element was used with the HFIRCE-3 element to study the interaction of two submerged elements in close proximity. The interaction was found to be very small if the elements were separated by 6 in. or more but was quite important if the separation was less than 4 in. For example, with the axes of the two elements in the same plane and a surface-to-surface separation of 1 in., and with storage posts in both target regions, the two-element system was critical with a water height which produced only a 2.49 in. top reflector. (auth)

35152 (SC-RR-66-203) DEVELOPMENT OF A NEUTRON RADIOGRAPHIC FACILITY AT THE SANDIA ENGINEERING REACTOR. (Sandia Corp., Albuquerque, N. Mex.). June 1966. Contract AT(29-1)-789. 22p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

This report describes the development of a neutron radiographic facility which operates in conjunction with the Sandia Engineering Reactor located at Sandia Laboratory, Albuquerque, New Mexico. The background and theory as well as some of the techniques used in neutron radiography are discussed. The facility provides a nondestructive testing capability using an available reactor as a neutron source. In addition to a good source of neutrons, radiographic work requires a well collimated beam of sufficient intensity to provide reasonable exposure time. The function of the auxiliary equipment designed and built for this purpose is described. Test results used to develop and to evaluate proper beam characteristics are included. The facility is now operational and available for potential application studies. The beam intensity and collimation are sufficient to provide reasonable exposure time and resolution for a variety of objects and materials. (auth)

35153 ACCUMULATION OF HYDROGEN PEROXIDE IN PRIMARY COOLING SYSTEM OF VVR-M REACTOR. Saikov, Yu. P.; Isupov, V. K. At. Energ. (USSR), 20: 356-7(Apr. 1966). (In Russian).

The results of an analysis of the concentration of hydrogen peroxide in the water of the primary cooling system as a function of reactor operating time and of reactor power are presented. (G.O.Y.)

35154 TR-0 HEAVY WATER ZERO-POWER REACTOR OF NUCLEAR RESEARCH INSTITUTE OF CZECHOSLOVAKIAN ACADEMY OF SCIENCES. Chochlovsky, Igor (Chemoprojekt, Prague); Riha, Karel; Panyr, Milos; Vorisek, Miroslav; Chamrad, Bretislav. Jad. Energ., 12: 161-5(1966). (In Czech).

The zero-power heavy water reactor TR-0, a pulsed neutron source and an exponential heavy water system, is described. This reactor has rod-shaped fuel elements of natural uranium. The active zone has a diameter of 3500 mm and a height up to 4000 mm. Its auxiliary layout was selected so that long-term studies on heavy water reactor lattices could be carried out. The principles of the long-term experimental program are outlined. The engineering solutions with respect to the reactor vessel and its system for the automatic adjustment of the lattice support and to the reactor circuits are described. The principal circuits considered are the heavy water circuit and the inert gas circuit in which dry air is used. A brief description is given of the construction work. (tr-auth)

35155 CRITICALITY OF THE 4-Mw WWR-S REACTOR. Meyer, K. (VEB Atomkraftwerk Rheinsberg, Berlin). Kernenergie, 9: 120-1(Apr. 1966).

The results of critical experiments for the new core of the WWR-S reactor are presented. The increase in the critical mass, with respect to the original core, is explained. (D.C.W.)

35156 OPERATION OF THE FR2 RESEARCH REACTOR. Eisermann, W. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 8: 249-52(June 1966). (In German).

The operation of the FR2 research reactor from the beginning of 1964 to October 19, 1965, was reported and some experiences gained are described. (J.S.R.)

35157 UTILIZATION OF THE REACTOR FR2 FOR RESEARCH PURPOSES. Oehme, H.; Marth, W. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 8: 253-6(June 1966). (In German).

The facilities of the FR2 reactor for irradiation channel experiments and capsule experiments are briefly outlined. A schematic drawing is given of the fuel irradiation rig. Proposed loop experiments and facilities are outlined. (J.S.R.)

35158 LOW-TEMPERATURE IRRADIATION FACILITY AT THE KARLSRUHE RESEARCH REACTOR FR2. Decker, W.; Diehl, J.; Hain, K.; Katheder, H.; Leitz, Ch. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 8: 257-63(June 1966). (In German).

The basic requirements of a low-temperature irradiation installation are outlined. The characteristics of the coolant circuit are given in some detail. The method used for the calculation of the counter current heat exchange is given. (J.S.R.)

35159 IRRADIATION OF A THERMIONIC EMITTER IN THE REACTOR FR2. Merges, V.; Winkenbach, H. (Kernforschungszentrum, Karlsruhe, Ger. Brown Boveri and Cie, AG, Mannheim, Ger.). Kerntechnik, 8: 263-6 (June 1966). (In German).

The irradiation rig and the technique used in the irradiation of a thermionic emitter are described in some detail. The construction and operation of the monitoring system for the experiments are outlined. (J.S.R.)

35160 FR2 ROTATING-CRYSTAL SPECTROMETER AT KARLSRUHE. Ripfel, H. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 8: 267-72(June 1966). (In German).

The general properties of the rotating crystal spectrometer are outlined, and its technical specifications are given. A typical time-of-flight spectra obtained is shown. (J.S.R.)

35161 DOUBLE COMPUTER SYSTEM FOR THE ON-LINE DATA PROCESSING AT THE REACTOR FR2. Krueger, G.; Dimmler, G.; Zipf, G.; Hanak, H.; Merkel, R. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 8: 273-8(June 1966). (In German).

The core of the MIDAS (multiple input data aquisition system) is the on-line computer which detects, accepts, processes and stores the measurement data from 8 experiments. The systems of the MIDAS are described, and the programming is outlined. (J.S.R.)

35162 HIGH-FLUX-BEAM REACTOR CONTROL-ROD BLADES AND DRIVE MECHANISMS. Godel, J. B.; Hendrie, J. M. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 10-11(June 1966).

35163 DESIGN AND TESTING OF A NEW FUEL CONCEPT FOR THE POWER BURST FACILITY. Kern,

R. S. (Phillips Petroleum Co., Idaho Falls, Idaho). Trans. Amer. Nucl. Soc., 9: 62-3(June 1966).

35164 CRITICAL EXPERIMENTS FOR THE ARGONNE ADVANCED RESEARCH REACTOR. Plumlee, K. E.; Daughtry, J. W.; Johnson, T. W.; Robinson, W. R.; Stanford, G. S. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc., 9: 182-3(June 1966).

35165 THE SORA CRITICAL EXPERIMENTS. Kistner, Gustav; Mihalczo, John T. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 184-5(June 1966).

35166 UPDATING EDUCATIONAL EXPERIMENTS FOR A LOW-POWERED REACTOR. Chandler, Ekillis M.; Quddus, M. A.; Cochran, R. G. (Texas Agricultural and Mechanical Univ., College Station). Trans. Amer. Nucl. Soc., 9: 211-12(June 1966).

35167 FAULT EXPERIENCE ON THE NRU DUAL-COMPUTER SYSTEM. Wells, N. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Trans. Amer. Nucl. Soc., 9: 264-5(June 1966).

35168 OPERATIONAL PROBLEMS WITH THE HEALTH PHYSICS RESEARCH REACTOR. Holland, L. B.; Gilley, L. W.; Poston, J. W.; Ward, D. R. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc., 9: 281(June 1966).

35169 ASTR LOSS-OF-FLUID COOLANT TEST. Lawrence, R. A. (Southern Methodist Univ., Dallas); Pancoast, J. T. Trans. Amer. Nucl. Soc., 9: 298-9(June 1966).

35170 THE EFFECT OF XENON ON SAFETY OF THE HFBR. Lellouche, G. S.; Chernick, J. (Brookhaven National Lab., Upton, N. Y.). Trans. Amer. Nucl. Soc., 9: 300-1(June 1966).

35171 NEUTRON TRANSPORT THEORY ANALYSIS OF CENTRAL WATER GAP EFFECTS IN THE CORNELL UNIVERSITY CRITICAL ASSEMBLY. Schilling, William Ernst. Ithaca, N. Y., Cornell Univ., 1965. 240p.

Thesis.

A three-step method is developed for detailed analysis of the effects of central water gaps in light-water lattices. First a detailed study of the spatially dependent thermal spectrum in the unperturbed unit cell is made. These calculations are carried out with program DOSE, a multigroup DS_4 computer program written in FORTRAN-63 for the CDC 1604. The results of the unit cell problems are used to get thermal multigroup constants for a homogenized unit cell region. A set of constants for a single thermal group is derived from the results of the supercell calculations for use in the central water region and in the first adjacent cell region. Thermal constants for the rest of the fuel regions are obtained from the unit cell calculations. In the final step a few-group DS_4 code, program CURFEW, using the single thermal group constants described above, is used to obtain the eigenvalues of the cores with and without the central fuel rod. The calculated central fuel rod worths are compared directly with experimentally measured values of reactivity on the Cornell Critical Assembly cores. DSN calculated thermal neutron density shapes in the central water gap are compared to experimental activation rates. Agreement is obtained that is compatible with the experimental and calculation techniques used. However, diffusion theory predicts a thermal flux peak as much as 11% lower than that predicted by the DSN method. Changes in the thermal constants result in less than a 4% change in the predicted thermal flux peaks. Certain calculational aspects of the study, especially the development of the DOSE and CURFEW computer codes, are emphasized. The difference between the use of linear anisotropic scattering and Honeck's transport approximation is investigated. A study is made of the cylindrical cell effect. (TCO)

WASTE DISPOSAL AND PROCESSING

See also BIOLOGY AND MEDICINE — Ecology
CHEMISTRY — Radiochemistry
CHEMISTRY — Separation Processes and Procedures
HEALTH AND SAFETY

35172 (BNWL–181) BURIED RADIOACTIVE WASTE STORAGE TANK TEMPERATURES AND SOIL TEMPERATURES NEAR LEAKS. Jansen, G. Jr.; Willingham, W. E.; DeMier, W. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1966. Contract AT(45-1)-1830. 69p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Temperatures and heat losses around waste tanks containing boiling solutions are compared for surrounding soil under dry conditions (low thermal conductivity) and under wet conditions (high thermal conductivity). Temperatures that might be attained in sludge-containing tanks resulting from liquid removal are also considered along with heat associated with leaks. A computer program is included for calculating heat rise around leaks. (J.R.D.)

35173 (IDO–14662) OPERATION OF THE WASTE CALCINING FACILITY WITH HIGHLY RADIOACTIVE AQUEOUS WASTE. Report of the First Processing Campaign. Commander, R. E.; Lohse, G. E.; Black, D. E.; Cooper, E. D. (Phillips Petroleum Co. Idaho Falls, Idaho. Atomic Energy Div.). June 1966. Contract AT(10-1)-205. 70p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The world's first major breakthrough in treating high-level radioactive aqueous waste was achieved by converting radioactive waste solutions to solids. From December 1963 to October 1964, about 512,000 gallons of waste containing up to 40 curies of various radionuclides per gallon were calcined in an air-fluidized bed heated to 400°C by means of a liquid-metal heat transfer system. An operating factor of 99.2% was achieved during this campaign. Decontamination of the off-gas from the fluidized bed was excellent. (auth)

35174 SOLIDIFICATION AND LONG-TERM STORAGE OF HIGHLY RADIOACTIVE WASTES. Grover, J. R. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Eng., 11: 382-6(May 1966).

A brief survey of process development for the solidification of highly radioactive wastes is presented. Some proposals for the storage of highly radioactive solids are also summarized. (D.C.W.)

35175 DISPOSAL OF RADIOACTIVE WASTES BY HYDRAULIC FRACTURING. PART III. DESIGN OF ORNL'S SHALE-FRACTURING PLANT. Weeren, H. O. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design, 4: 108-17(May-June 1966). (ORNL-P–2104).

The shale fracturing program has been concerned with the development of a technique for the safe and economic disposal of large batches of radioactive waste by mixing the waste with cement and injecting the mix into beds of shale at depths of about 1000 ft. A facility was built at ORNL to make a series of seven experimental injections. Large volumes of waste solution (up to 150,000 gallons per injection) were successfully injected. Precise control of the proportion of cement and waste solution remains a difficult problem. The facility is now scheduled for modification for regular disposal of laboratory waste. (auth)

35176 FLUID FLOW FROM NUCLEAR CHIMNEYS. Korver, John A. (Univ. of California, Livermore). Contract W-7405-eng-48. Water Resour. Res., 2: 297-331 (1966). (UCRL–12236).

One engineering use for nuclear explosives is the creation of large underground rubble chimneys into which liquid wastes can be injected. A second application is the creation of surface craters for water storage or the recharge of groundwater basins. To assess the feasibility of these two classes of applications, a predictive capability was developed by matching laboratory model studies with mathematical analogs. Two different hydrologic environments were studied; flow into confined and unconfined aquifers. The effects of varying permeability, porosity, input flow rates, and well or chimney dimensions were examined. Variation between laboratory and mathematical model results was less than 10%. The laboratory model studies of two hydrologic environments, the development of the mathematical models, and the numerical solutions obtained with the mathematical models are described. The use of rubble chimneys is emphasized, but the principles developed apply equally well to the hydraulic behavior of surface craters. Also described are several case histories of potential applications of nuclear explosives to the field of waste injection and storage. The results of these investigations indicate that, for many selected hydrologic conditions, it is feasible to use nuclear rubble chimneys in permeable but unsaturated formations for the disposal, storage, or conservation of liquid wastes. Depending on the particular application and the hydraulic properties, rubble chimneys can be expected to have useful lifetimes of from one to perhaps more than one hundred years. (auth)

35177 FISSION-PRODUCTS-CONTAINING COMPOSITION AND PROCESS OF MAKING. Rushbrook, Peter R. (to U. S. Atomic Energy Commission). U. S. Patent 3,262,885. July 26, 1966.

A new composition of matter, comprising a melted and cooled mixture of from 20 to 50% by weight of zeolite with from 40 to 10% of lithium fluoride, from 40 to 10% of silica and from 10 to 50% of boron oxide, and the method of making same is described. (AEC)

GENERAL AND MISCELLANEOUS

35178 (BNWL–113-16) PLUTONIUM ABSTRACTS, Volume 6, Number 4. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 31, 1966. Contract AT(45-1)-1830. 52p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

Abstracts are presented that contain information on the biology and medicine, chemistry, health and safety, metallurgy and ceramics, physics, and reactor technology associated with plutonium. (J.R.D.)

35179 (ORNL–3300(Vol.5)) PUBLICATIONS, REPORTS, AND PAPERS FOR 1965 FROM OAK RIDGE NATIONAL LABORATORY. Johnsson, K. O.; Haas, Ann S. (eds.) (Oak Ridge National Lab., Tenn.). June 1966. Contract W-7405-eng-26. 350p. Dep. mn. CFSTI $4.00 cy, $1.75 mn.

A bibliographic reference to technical information is presented. About half of the listed entries have appeared in technical journals or technical reports. Papers presented at professional society meetings are listed along with books, portions of books, and theses prepared by staff members. A key word index and an author index are included. (J.R.D.)

35180 (ORNL-NSIC–18) COMPILATION OF NATIONAL AND INTERNATIONAL NUCLEAR STANDARDS (EXCLUDING U.S. ACTIVITIES). 2nd Edition, 1966. (Oak Ridge National Lab., Tenn.). June 1966. Contract W-7405-eng-26. 39p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

The national nuclear standards activities for Australia, Austria, Belgium, Canada, France, Germany, India, Israel, Japan, Netherlands, Norway, Pakistan, Republic of South Africa, Sweden, United Kingdom, and Yugoslovia are outlined. The nuclear standards activities of international organizations are outlined also. (M.O.W.)

35181 (SRIA–115P49-1) STATISTICAL AND INVENTORY PROCEDURES APPLIED TO NUCLEAR MATERIALS MANAGEMENT. Final Report. Dresch, F. W.; Butterfield, P. H.; Kinderman, E. M. (Stanford Research Inst., Menlo Park, Calif.). Apr. 1966. Contract AT(04-3)-115. 111p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

An analysis is presented of methods used by AEC contractors for monitoring reports of nuclear materials management book physical inventory difference (BPID), material unaccounted for (MUF), net operating loss (NOL), and shipper-receiver difference (S/R). Improved methods are recommended including centralized data reporting, and application of analysis to inventory management and materials control. (J.R.D.)

35182 (STI/DOC–10/55) IAEA LABORATORY ACTIVITIES. Third Report. Technical Reports Series. (International Atomic Energy Agency, Vienna (Austria)). 1966. 160p. IAEA: $1.00; S21,-; 6/stg.; F Fr 4,-; DM 3,20.

Work at the IAEA laboratories at Vienna and Seibersdorf, the International Laboratory of Marine Radioactivity at Monaco, the International Centre for Theoretical Physics at Trieste, and the Middle Eastern Regional Radioisotope Center for the Arab countries at Cairo is described. Separate abstracts were prepared for the reports from each group. (M.C.G.)

For abstracts of individual sections see: 33502, 33979, 35189, and 35190.

35183 (UCSD–34P127-1) RESEARCH INTO THE NEAR-BOTTOM WATERS AND OTHER STUDIES OFF SOUTHERN CALIFORNIA. Isaacs, John D.; Schwartzlose, Richard A.; Reid, Joseph L. Jr.; Schick, George B.; Brown, Daniel M.; Alvarino, Angeles; Kobayashi, B. N. (Scripps Institution of Oceanography, La Jolla, Calif.). May 16, 1966. Contract AT(11-1)-34. 64p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Cruises were conducted during which near-bottom current measurements were made, samples were collected using deep stratified net tows and bottom fish traps, and bottom photographs were made. Information gained in the research is discussed. Data and photographs are included. (J.R.D.)

35184 (Y–1400(Rev.1)) CUBIC SPLINE: A CURVE FITTING ROUTINE. Fowler, A. H.; Wilson, C. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). June 28, 1966. Contract W-7405-eng-26. 98p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

A method of mathematically fitting a curve through a given ordered set of points was developed and programmed in FORTRAN computer language. The fitted curve, which is made up of a series of normalized cubic polynomials, very nearly approximates the curve generated by passing an infinitely thin spline through the sets of points and is, therefore, called a "cubic spline." The curve has the properties of continuous position, slope, and curvature. The restraints placed upon the cubic spline may be relaxed by applying an additional feature which permits the points to be adjusted by, at most, some preset value. This has the effect of smoothing the curve in the sense that it reduces the strain energy stored in it while preserving the general shape of the curve. Tool centers for numerically controlled tools may be found with the interpolation and offsetting methods included. (auth)

35185 (Y–1539) PHOTOELASTIC ANALYSIS OF STRESS WAVES RESULTING FROM EXPLODING WIRES. Thompson, W. H. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 1, 1966. Contract W-7405-eng-26. 58p. CFSTI $3.00 cy, $0.75 mn.

The development of a photoelastic system capable of visualizing dynamic stress waves traveling through transparent plastics is reported. Large amplitude stresses were created in plastics with relatively high elastic moduli by the force imparted by an exploding wire. A 42,000-joule energy-storage capacitor bank provided the energy necessary to explode the wire. The type of wave traveling through the plastic plates was found to be analogous to Lamb wave propagation in plates. A piezoelectric transducer was used along with the photoelastic pictures to verify this analogy. (auth)

35186 (Y–1540) ULTRASONIC INTERACTIONS AT LIQUID-SOLID BOUNDARIES. Garber, J. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 1, 1966. Contract W-7405-eng-26. 80p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

A review is made of the theoretical equations predicting the relative energies and propagation directions of waves produced by a plane ultrasonic wave incident at different angles on a liquid-solid boundary. The following three cases are considered: a longitudinal wave incident from a liquid onto a solid; a longitudinal wave incident from a solid onto a liquid; and a shear wave incident from a solid onto a liquid. A computer program, written for making calculations of the energy ratios, is used to aid in predicting the general characteristics of ultrasonic interactions for many types of liquid-solid systems. Unusual predictions involving extreme points of the energy ratios are noted for extreme values of the Poisson's ratio of the solid. Experimental measurements are reported for the energy reflected as a function of incident angle in water of a longitudinal wave incident on flat samples of aluminum and beryllium. The effects of surface waves are observed. (auth)

35187 (JPRS–35342) TRANSLATIONS ON COMMUNIST CHINA'S SCIENCE AND TECHNOLOGY NO. 313. 21p. (TT–66-31778). CFSTI $1.00 cy, $0.50 mn.

Summaries or translations of selected articles on Communist China's science and technology are presented. Topics covered include: reference manual of standard

programs for the 104 electronic digital computer, mutual influence between the effects of radiation and the crystallization properties of polyethylene, game preserve control station at Lake Kokonor, and research on karst in China. A separate abstract was prepared for one paper. (M.C.G.)

For an abstract of the individual paper see: 33339.

35188 NUCLEAR BIBLIOGRAPHY AND FACILITIES SURVEY (COMPILED BY THE INSTITUTE OF ENVIRONMENTAL SCIENCES NUCLEAR RADIATION COMMITTEE). Surosky, Alan E. J. Environ. Sci., 9: 22-5(Apr. 1966).

The bibliography of nuclear science literature is intended as a specific guide to the environmental engineer rather than as a comprehensive survey of the entire field of nuclear science and engineering. The survey of facilities list itemizes primarily those installations (responding to an Institute of Environmental Sciences information request) that have indicated an interest in the type of program germane to Institute activities. A more comprehensive listing of facilities may be found in the documents that are referred to and that are from the Radiation Effects Information Center (REIC), Battelle Memorial Institute, Columbus, Ohio. Source material was organized into logical areas of interest as follows: atomic and nuclear physics; radiation interactions with matter; nuclear radiation effects in materials and components; nuclear weapons effects; radiation testing and dosimetry; nuclear radiation handbooks. Publications listed are classified as to their general academic level, such as, elementary, intermediate, or advanced. (BBB)

35189 THE IAEA LABORATORIES AT VIENNA AND SEIBERSDORF. pp 1-100 of STI/DOC-10/55.

Research in physics, chemistry, hydrology, medical physics, agriculture, and electronics is reported. (M.C.G.)

35190 THE MIDDLE EASTERN REGIONAL RADIOISOTOPE CENTRE FOR THE ARAB COUNTRIES, CAIRO. pp 135-51 of STI/DOC-10/55.

Research programs in hydrology, agriculture, entomology, and medicine are described. (M.C.G.)

35191 SYSTEM PLANNER'S VIEW OF THE ECONOMIC SIGNIFICANCE OF PLANNED AND FORCED OUTAGES OF GENERATING CAPACITY. Vassell, G. S.; Tibberts, N. (American Electric Power Service Corp., New York). Trans. Amer. Nucl. Soc., 9: 217-18(June 1966).

CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

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ä	becomes	ae
ö		oe
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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included in cumulative indexes to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Gland and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair. However, the information would not be indexed under the experimental animal, e.g., Rats, unless the report discusses the effects on rat hair as compared with the effect on the hair of other animals.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings, e.g., Amino Acids rather than Acids, Amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases parenthetic modifying terms or inverted headings of the form Neutrons, Fast are used in preference to a direct entry that would result in the scattering of information. Organic compounds are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of Chemical Abstracts, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are alphabetized word-by-word. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out.

Examples:

M-Capture
see Electron Capture
Magnesium
Magnesium Alloys
Manganese Fluorides
Manganese(II) Fluorides
Mesons
Mesons (π)
Mesons (ρ)
3-Pentanol, 2,4-Dimethyl-
2-Pentanol, 2-Methyl-
2-Pentanol, 4-Methyl-

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Alloys and Other Systems

Multicomponent alloys, except well-known trade names, are indexed under a main heading in the form "element alloy" for each element in the alloy. The modifier begins with element symbols for each component arranged alphabetically as if the English name for the element were spelled out.

Example: Copper-Gold Alloy is indexed
Copper Alloys
Cu-Au...
Gold Alloys
Cu-Au...

Well-known alloys such as Zircaloy-2 are indexed directly to the trade name; cross references referring from each component of the alloy to the entry for the trade name appear in cumulative indexes.

Multicomponent systems of non-metallic elements are indexed in a manner similar to alloys except the main heading used contains the word "Systems" in place of "Alloys."

Example: Silicon–Tungsten Systems are indexed
Silicon Systems
Si-W...
Tungsten Systems
Si-W...

Multicompound systems and mixtures of compounds are indexed under the main heading for each component com-

pound; the modifiers begin with an alphabetical listing of compound formulas.

Example: Lead Titanate–Lead Zirconate is indexed
Lead Titanates
$PbTiO_3$-$PbZrO_3$...
Lead Zirconates
$PbTiO_3$-$PbZrO_3$...

A mixed system of compounds and elements is indexed using a combined form of the above conventions, e.g., a dispersion of copper and alumina would be indexed

Aluminum Oxides
Al_2O_3-Cu...
Copper Systems
Al_2O_3-Cu..

Physical States and Configurations of Materials

Specification of the physical state, if other than normal, or geometric configuration of the material is included in the modifying phrase, i.e., liquid metals would be indexed to the metal with "liquid" in the modifier, and carbon crucibles would be indexed to Carbon with "crucibles" appropriately placed in the modifier and also to Crucibles if appropriate.

Modifying Phrases

The modifiers appearing under a main heading are written specifically to describe the relation of the item being indexed to that main heading. The modifier, therefore, will generally contain more useful information about that relation than will a title or a phrase written to be used under every main heading assigned to the item. Effort is exerted to begin the modifier with the word judged to be of greatest use to the greatest number of users; this, however, does not obviate the need to consider all modifiers under the main heading(s) of interest.

Modifiers are usually intended to form a meaningful phrase when combined with the main heading. Some are intended to be read following the main heading, e.g., the entry Hydrogen—sorption by charcoal is read "hydrogen sorption by charcoal"; however, as a result of placing the important word first, many modifiers must be arranged for smooth reading, e.g., Formaldehyde—yields in radiolysis of ethyl ether, effects of deuterium on is read "effects of deuterium on formaldehyde yields in radiolysis of ethyl ether" and Uranium—crystal structure of, effect of cooling rate on allotropic transformations in is read "effect of cooling rate on allotropic transformations in crystal structure of uranium." Prepositions are sometimes omitted if no ambiguity results.

Special characters are added to modifiers in the field of physics; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the journal reference number. The value of this identification has been established by the American Institute of Physics.

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If published proceedings are received after the receipt of individual papers, the complete proceedings will be abstracted and the abstract number will appear in this index with the base CONF number.

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35	20-33618	Dep. mn. CFSTI $1.00 cy, $0.50 mn
45	20-34905	See GA-7059
CONF-660304–	20-33646	(Institute of Electrical and Electronics Engineers, Scintillation and Semiconductor Counter Symposium, Washington, D. C., Mar. 2–4, 1966) Trans. Nucl. Sci., NS-13: No. 3, 1-601(1966)
21	20-33634	See UCRL-16542
CONF-660306–		(American Physical Society, Conference on Isobaric Spin, Tallahassee, Mar. 17–19, 1966)
10	20-34527	See RLO-1388B-6
CONF-660308–	20-35004	(American Nuclear Society, Plutonium Information Meeting, Washington, D. C., Mar. 1–2, 1966) Dep. mn. CFSTI $3.00 cy, $1.50 mn
CONF-660310–		(AIAA 5th Electric Propulsion Conference, San Diego, Calif., Mar. 7–9, 1966)
18	20-34771	ORAU
CONF-660320–		(American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22–31, 1966)
2	20-33256	Dep. mn. CFSTI $1.00 cy, $0.50 mn
3	20-33321	Dep. mn. CFSTI $1.00 cy, $0.50 mn
CONF-660408–		(Instrument Society of America, Southeastern Conference and Exhibit, Augusta, Ga., Apr. 19–21, 1966)
1	20-34887	See DP-MS-66-10
4	20-33601	See DP-MS-66-5
CONF-660411–		(American Physical Society Meeting, Washington, D. C., Apr. 25–28, 1966)
2	20-34153	See ORO-3065-9
CONF-660420–		(International Conference on Two-Body Problems at High Energy, Stony Brook, N. Y., Apr. 22–23, 1966)
1	20-34145	See BNL-10215
CONF-660424–		(Conference on the Fallout at the Naval Radiological Lab., Monterey, Calif., Apr. 12–14, 1966)
1	20-33511	See UCRL-14668
CONF-660510–		(International Conference on Isochronous Cyclotrons, Gatlinburg, Tenn., May 2–5, 1966)
9	20-33988	See ORNL-P-2262
11	20-33989	See UCRL-16727
12	20-33990	See UCRL-16882
CONF-660511–		(International Symposium on Capsule Irradiation Experiments, Pleasanton, Calif., May 3–5, 1966)
4	20-34890	See ORNL-P-2177
6	20-33604	See ORNL-P-2179
8	20-33605	See UCRL-14766
9	20-33940	See DP-MS-66-1
CONF-660518–		(AEC Annual Metallography Meeting, Denver, May 18–20, 1966)
2	20-33146	See BNWL-SA-592
3	20-33474	See BNWL-SA-594
4	20-33882	See NLCO-978
5	20-33881	See NLCO-977
6	20-33941	See DP-MS-66-9
CONF-660524–		(2nd International Thorium Fuel Cycle Symposium, Gatlinburg, Tenn., May 3–6, 1966)
5	20-35026	See ORNL-P-2178
6	20-33414	See ORNL-P-2192
CONF-660530–		(4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy, May 23–27, 1966)
1	20-34700	See IPP-4/37
2	20-34699	See IPP-4/36
3	20-34698	See IPP-4/34
4	20-34693	See IPP-4/27
5	20-34694	See IPP-4/28
6	20-34696	See IPP-4/30
7	20-34692	See IPP-4/26
8	20-34695	See IPP-4/29
9	20-34415	See IPP-4/31
10	20-34697	See IPP-4/32
CONF-660532–		(Atomic Energy Commission Traffic Management Conference, Las Vegas, Nev., May 10–12, 1966)
1	20-33559	See ORNL-P-2161
CONF-660605–		(Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966)
3	20-33560	See UCRL-16730
CONF-660606–	20-34872	(American Nuclear Society Meeting, Denver, June 19–23, 1966) Trans. Amer. Nucl. Soc., 9: 1-322(1966)
3	20-34904	Dep. mn. CFSTI $1.00 cy, $0.50 mn
4	20-35018	See DP-MS-66-38
5	20-33259	See ORNL-P-2265
6	20-33435	See UCRL-12248-T(Rev.1)
7	20-33554	See ISO-SA-4
8	20-34469	See DP-MS-66-30
CONF-660607–		(3rd International Symposium on the Effects of Irradiation on Structural Metals, Atlantic City, June 29–July 1, 1966)
2	20-33814	See COO-1319-40
CONF-660611–		(Society of Applied Spectroscopy Meeting, Chicago, June 14–15, 1966)
3	20-33154	See NLCO-979
CONF-660612–		(Symposium on Organic Scintillators, Argonne, Ill., June 20–22, 1966)
1	20-33332	See EGG-1183-2099
CONF-660613–		(US/UK Libby-Cockcroft Irradiation Effects Meeting, Upton, N. Y., June 23–24, 1966)
1	20-33946	See ORNL-TM-1516
CONF-660614–		(3rd International Congress on Radiation Research, Cortina, Italy, June 1966)
1	20-33338	See RRL-2310-180
CONF-660615–		(American Chemical Society, Northwest Regional Meeting, Vancouver, B. C., June 16–17, 1966)
4	20-33152	See ISO-SA-8
CONF-660617–		(American Assn. for Contamination Control, Boston, June 21, 1966)
1	20-33447	See Y-EF-10
CONF-660619–		(3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif., June 13–16, 1966)
1	20-33258	See ORNL-P-2264
CONF-660621–		(Health Physics Society, 11th Annual Meeting, Houston, Tex., June 27–30, 1966)
3	20-33633	See UCRL-14633
CONF-660622–		(Royal Meteorological Society, National Meteorology Congress, Sherbrooke, Quebec, Canada, June 8–10, 1966)
1	20-33503	See AECL-2575
COO–		
7-0365	20-34516	Dep. mn. CFSTI $2.00 cy, $0.50 mn
30-106	20-34220	Phys. Rev., 147: 1115-17(1966)
264-278	20-34217	Phys. Rev., 147: 1080-93(1966)
498-48	20-34570	Nucl. Phys., 84: 618-28(1966)
733-13	20-33143	Dep. mn. CFSTI $2.00 cy, $0.50 mn
881-70	20-34232	Phys. Rev. Lett., 17: 45-8(1966)
1199-8	20-33508	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1224-7	20-33387	pp 37-59 of Energy Transfer in Radiation Processes. Phillips, Glyn O. (ed.). New York, Elsevier Publishing Co., 1966
1319-40	20-33814	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1545-5	20-33619	Dep. mn. CFSTI $1.00 cy, $0.50 mn
CSR-TR–	(Non-AEC)	
66-1	20-34332	See N-66-16250
CTO–	(Non-AEC)	

Report No.	Abstract No.	Availability
224	20-34082	For translation see NP-tr-1376
CU–	**(Misc.)**	
252	20-34204	See CU-1932-252
256	20-34146	See CU-1932-256
1019-49	20-34517	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1932-252	20-34204	Phys. Rev., 147: 939-41(1966)
1932-256	20-34146	Dep. mn. CFSTI $3.00 cy, $0.75 mn
DESY–	**(German)**	
66/11	20-34147	Dep. mn
DL–	**(Canadian)**	
70	20-34467	See AECL-2557
DP–		
1013	20-33453	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1051	20-33939	Dep. mn. CFSTI $2.00 cy, $0.50 mn
DP-MS–		
66-1	20-33940	Dep. mn. CFSTI $1.00 cy, $0.50 mn
66-5	20-33601	Dep. mn. CFSTI $1.00 cy, $0.50 mn
66-9	20-33941	Dep. mn. CFSTI $1.00 cy, $0.50 mn
66-10	20-34887	Dep. mn. CFSTI $2.00 cy, $0.50 mn
66-30	20-34469	Dep. mn. CFSTI $1.00 cy, $0.50 mn
66-38	20-35018	Dep. mn. CFSTI $1.00 cy, $0.50 mn
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EFINS–	**(Misc.)**	
65-79	20-34217	See COO-264-278
65-89	20-34008	See N-66-12966
EGG–		
1183-1210	20-33445	Dep. mn. CFSTI $5.00 cy, $1.00 mn
1183-2084	20-33663	IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 153-8(1966)
1183-2099	20-33332	Dep. mn. CFSTI $1.00 cy, $0.50 mn
EUR–	**(European Atomic Energy Community)**	
2357	20-33456	See EURAEC-1398
2537.i	20-35019	Dep. mn
2766.e	20-35020	Dep. mn
2775.d	20-33454	Dep. mn
2793.e	20-33620	Dep. mn
2808	20-35021	See EURAEC-1577
2836	20-33865	See EURAEC-1623
2838	20-33815	See EURAEC-1625
2847	20-33866	See EURAEC-1649
2951.f	20-33148	Dep. mn
2953.e	20-34470	Dep. mn
2955.i	20-33149	Dep. mn
2961.f	20-33509	Dep. mn
2965.e	20-33553	Dep. mn
2969.d	20-33602	Dep. mn
2982.e	20-33455	Dep. mn
2984.e	20-34870	Dep. mn
EURAEC–		
1398	20-33456	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1577	20-35021	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1615	20-33864	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1623	20-33865	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1625	20-33815	Dep. mn. CFSTI $4.00 cy, $1.00 mn
1649	20-33866	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1655	20-33945	See NUMEC-3505-14
FTD-TT–	**(Non-AEC)**	
65-1890	20-34711	For translation see AD-630972
FZK–	**(Non-AEC)**	
219	20-33333	See N-66-13092
291	20-33506	See AD-634534
GA–	**(Misc.)**	
6335	20-34702	See N-65-34392
7059	20-34905	Dep. mn. CFSTI $1.00 cy, $0.50 mn
7064	20-34471	
7130	20-35022	Dep. mn. CFSTI $2.00 cy, $0.50 mn
GAMD–	**(Misc.)**	
6616	20-35023	Dep. mn. CFSTI $1.00 cy, $0.50 mn
GEAP–	**(Misc.)**	
4849	20-33867	Dep. mn. CFSTI $6.00 cy, $2.00 mn
5135	20-35024	Dep. mn. CFSTI $2.00 cy, $0.50 mn
GEMP–	**(Misc.)**	
59A	20-33770	Dep. mn. CFSTI $3.00 cy, $0.75 mn
414	20-33816	Dep. mn. CFSTI $1.00 cy, $0.50 mn
IBJ–	**(Polish)**	
See INR		
IBK–	**(Yugoslavian)**	
435	20-34815	Dep. mn
IC–	**(Misc.)**	
66/43	20-34148	Dep. mn
66/60	20-34258	Dep. mn
66/61	20-34149	Dep. mn
66/66	20-34259	Dep. mn
66/69	20-34260	Dep. mn
IDO–		
10047	20-33445	See EGG-1183-1210
14662	20-35173	Dep. mn. CFSTI $3.00 cy, $0.75 mn
14674	20-33411	Dep. mn. CFSTI $1.00 cy, $0.50 mn
17157	20-33942	Dep. mn. CFSTI $4.00 cy, $0.75 mn
17170	20-34816	Dep. mn. CFSTI $3.00 cy, $0.50 mn
17179	20-35148	Dep. mn. CFSTI $3.00 cy, $0.75 mn
IEA–	**(Brazilian)**	
105	20-33150	Dep. mn
109	20-33412	Dep. mn
IITRI–	**(Misc.)**	
A6141-QR1	20-34007	See N-66-12863
G6003-2	20-33876	See N-66-17087
INR–	**(Non-AEC)**	
680/I/PH	20-34518	Dep.
683/VI/PH	20-34519	Dep.
702/II/PS	20-34817	Dep.
INSJ–	**(Japanese)**	
97	20-34520	Dep. mn
IPP–	**(Non-AEC)**	
4/26	20-34692	Dep. mn
4/27	20-34693	Dep. mn
4/28	20-34694	Dep. mn
4/29	20-34695	Dep. mn
4/30	20-34696	Dep. mn
4/31	20-34415	Dep. mn
4/32	20-34697	Dep. mn
4/34	20-34698	Dep. mn
4/36	20-34699	Dep. mn
4/37	20-34700	Dep. mn
IPST-Cat.–	**(Russian)**	
2173	20-33311	New York, Daniel Davey and Co., Inc., 1966. $21.50
IS–		
1215	20-33322	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1315	20-33217	Talanta, 13: 1081-7(1966)
IS-T–		
82	20-33868	Dep. mn. CFSTI $3.00 cy, $0.75 mn
83	20-34150	Dep. mn. CFSTI $2.00 cy, $0.50 mn
87	20-33621	Dep. mn. CFSTI $3.00 cy, $0.50 mn
88	20-33151	Dep. mn. CFSTI $3.00 cy, $0.50 mn
90	20-33838	Dep. mn. CFSTI $3.00 cy, $0.50 mn
ISO-SA–		
4	20-33554	Dep. mn. CFSTI $1.00 cy, $0.50 mn
8	20-33152	Dep. mn. CFSTI $1.00 cy, $0.50 mn
ISS–	**(Italian)**	
66/15	20-34151	Dep. mn
JINR–	**(Russian)**	

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E-2663	20-34521	Dep. mn
E-2721	20-34522	Dep. mn
P-2675	20-33622	Dep. mn
P-2693	20-33984	Dep. mn
P-2695	20-34523	Dep. mn
P-2697	20-34261	Dep. mn
P-2711	20-34152	Dep. mn
P-2712	20-34524	Dep. mn
JPRS–	(Non-AEC)	
35342	20-35187	CFSTI $1.00 cy, $0.50 mn
K–		
1639	20-33153	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1669	20-33413	Dep. mn. CFSTI $3.00 cy, $0.50 mn
K-M–		
6013	20-33446	Dep. mn. CFSTI $1.00 cy, $0.50 mn
KFK–	(German)	
401	20-34525	Dep. mn
KR–	(Norwegian)	
103	20-35149	Dep. mn. CFSTI $1.00 cy, $0.50 mn
104	20-34888	Dep. mn
LA–		
3393	20-35120	Dep. mn. CFSTI $3.00 cy, $0.50 mn
3410	20-33869	Dep. mn. CFSTI $3.00 cy, $0.75 mn
3428	20-35121	Dep. mn. CFSTI $3.00 cy, $0.50 mn
3474	20-33603	Dep. mn. CFSTI $1.00 cy, $0.50 mn
3492	20-34416	Dep. mn. CFSTI $1.00 cy, $0.50 mn
3495	20-33771	Dep. mn. CFSTI $1.00 cy, $0.50 mn
LA-DC–		
6795	20-33850	J. Amer. Ceram. Soc., 49: 323-7(1966)
7366	20-34019	Astrophys. J., 144: 1024-37(1966)
7367	20-34020	Astrophys. J., 144: 1038-68(1966)
7741	20-33286	J. Chem. Phys., 45: 99-103(1966)
MATT–		
353	20-34701	Dep. mn. CFSTI $1.00 cy, $0.50 mn
363	20-34719	Ann. Phys. (N. Y.), 38: 63-94(1966)
MATT-Trans–		
28	20-34421	Dep. mn. JCL $1.60 fs, $0.80 mf
MIT–	(Misc.)	
1002-1	20-33870	Dep. mn. CFSTI $1.00 cy, $0.50 mn
2098-167	20-33623	Dep. mn. CFSTI $1.00 cy, $0.50 mn
2098-168	20-33624	Dep. mn. CFSTI $2.00 cy, $0.50 mn
2098-204	20-34205	Phys. Rev., 147: 941-5(1966)
2241-19	20-33505	pp 392-404 of Proceedings of the Second AEC Conference on Radioactive Fallout from Nuclear Weapons Tests, Germantown, Md., Nov. 3–6, 1964
MLM–		
1326	20-33625	Dep. mn. CFSTI $2.00 cy, $0.50 mn
MSAR–	(Misc.)	
66-119	20-33817	Dep. mn. CFSTI $1.00 cy, $0.50 mn
MURA–	(Misc.)	
700	20-33985	Dep. mn. CFSTI $1.75 cy, $0.75 mn
N–	(Misc.)	
65-30832	20-33871	CFSTI $4.00 cy, $0.75 mn
65-31175	20-33872	CFSTI $2.00 cy, $0.50 mn
65-31950	20-33839	CFSTI $2.00 cy, $0.50 mn
65-32043	20-33626	CFSTI $3.00 cy, $0.50 mn
65-32048	20-34078	CFSTI $3.00 cy, $0.75 mn
65-32092	20-33986	CFSTI $3.00 cy, $0.75 mn
65-32096	20-33987	CFSTI $2.00 cy, $0.50 mn
65-32113	20-33491	CFSTI $1.00 cy, $0.50 mn
65-32165	20-33943	CFSTI $2.00 cy, $0.50 mn
65-32169	20-33726	CFSTI $1.00 cy, $0.50 mn
65-32195	20-34079	CFSTI $3.80 cy, $0.75 mn
65-32252	20-34778	CFSTI $2.00 cy, $0.50 mn
65-34010	20-33944	CFSTI $1.00 cy, $0.50 mn
65-34392	20-34702	
65-34401	20-34353	CFSTI $5.00 cy, $1.00 mn
65-34464	20-34417	CFSTI $2.00 cy, $0.50 mn
66-10545	20-34330	CFSTI $4.00 cy, $0.75 mn
66-10647	20-33727	CFSTI $1.00 cy, $0.50 mn
66-10648	20-33627	CFSTI $3.00 cy, $0.75 mn
66-10681	20-34006	CFSTI $1.00 cy, $0.50 mn
66-11201	20-33728	CFSTI $1.00 cy, $0.50 mn
66-11230	20-34354	CFSTI $4.00 cy, $0.75 mn
66-12158	20-33492	CFSTI $2.00 cy, $0.50 mn
66-12185	20-34779	CFSTI $1.00 cy, $0.50 mn
66-12189	20-33729	CFSTI $1.00 cy, $0.50 mn
66-12193	20-33730	CFSTI $1.00 cy, $0.50 mn
66-12247	20-34122	CFSTI $2.00 cy, $0.50 mn
66-12349	20-33873	CFSTI $4.00 cy, $0.75 mn
66-12483	20-34703	CFSTI $3.00 cy, $0.50 mn
66-12863	20-34007	CFSTI $1.00 cy, $0.50 mn
66-12875	20-33818	CFSTI $1.00 cy, $0.50 mn
66-12928	20-33752	CFSTI $6.00 cy, $1.50 mn
66-12961	20-34123	CFSTI $3.00 cy, $0.75 mn
66-12966	20-34008	CFSTI $1.00 cy, $0.50 mn
66-13000	20-33493	CFSTI $4.00 cy, $1.00 mn
66-13027	20-34331	
66-13092	20-33333	CFSTI $4.00 cy, $1.00 mn
66-13124	20-35122	CFSTI $2.00 cy, $0.50 mn
66-13125	20-35123	CFSTI $6.00 cy, $1.50 mn
66-13174	20-33731	CFSTI $1.00 cy, $0.50 mn
66-13563	20-34780	CFSTI $2.00 cy, $0.50 mn
66-13638	20-34124	CFSTI $2.00 cy, $0.50 mn
66-14060	20-34125	CFSTI $3.00 cy, $0.50 mn
66-14377	20-35130	CFSTI $2.00 cy, $0.50 mn
66-14637	20-34355	CFSTI $4.00 cy, $1.00 mn
66-14955	20-34704	CFSTI $2.00 cy, $0.50 mn
66-16181	20-34418	CFSTI $3.00 cy, $0.75 mn
66-16250	20-34332	CFSTI $2.00 cy, $0.50 mn
66-16385	20-34356	CFSTI $2.00 cy, $0.50 mn
66-16393	20-34357	CFSTI $2.00 cy, $0.50 mn
66-16405	20-34009	CFSTI $2.00 cy, $0.50 mn
66-16420	20-33874	CFSTI $1.00 cy, $0.50 mn
66-16471	20-33840	CFSTI $1.00 cy, $0.50 mn
66-16495	20-34781	
66-16525	20-35124	CFSTI $7.00 cy, $1.75 mn
66-16551	20-33875	CFSTI $2.00 cy, $0.50 mn
66-16598	20-34705	CFSTI $2.00 cy, $0.50 mn
66-16697	20-34358	CFSTI $1.00 cy, $0.50 mn
66-16719	20-34706	CFSTI $2.00 cy, $0.50 mn
66-16920	20-33494	CFSTI $4.00 cy, $1.00 mn
66-16939	20-34080	CFSTI $2.00 cy, $0.50 mn
66-16975	20-34359	CFSTI $2.00 cy, $0.50 mn
66-16985	20-33732	CFSTI $1.00 cy, $0.50 mn
66-17087	20-33876	CFSTI $2.00 cy, $0.50 mn
66-17095	20-34707	CFSTI $2.00 cy, $0.50 mn
66-17104	20-33733	CFSTI $1.00 cy, $0.50 mn
66-17230	20-34360	CFSTI $1.00 cy, $0.50 mn
66-17233	20-34361	CFSTI $3.00 cy, $0.50 mn
66-17243	20-34362	CFSTI $1.00 cy, $0.50 mn
66-17248	20-34363	CFSTI $2.00 cy, $0.50 mn
66-17252	20-34364	CFSTI $2.00 cy, $0.50 mn
66-17257	20-34365	CFSTI $1.00 cy, $0.50 mn
66-17261	20-34333	CFSTI $2.00 cy, $0.50 mn
NAA-SR–		
10624	20-33841	Dep. mn. CFSTI $2.00 cy, $0.50 mn
NAA-SR-Memo–		
10557(Pt.1)(Rev.)	20-35150	Dep. mn. CFSTI $2.00 cy, $0.50 mn
11718	20-34782	Dep. mn. CFSTI $4.00 cy, $0.75 mn
11747	20-33495	Dep. mn. CFSTI $3.00 cy, $0.75 mn
11788	20-33877	Dep. mn. CFSTI $2.00 cy, $0.50 mn
11799	20-34906	Dep. mn. CFSTI $3.00 cy, $0.75 mn
11816	20-33628	Dep. mn. CFSTI $1.00 cy, $0.50 mn
11858	20-33457	Dep. mn. CFSTI $3.00 cy, $0.75 mn
11865	20-35125	Dep. mn. CFSTI $2.00 cy, $0.50 mn
11914	20-35126	Dep. mn. CFSTI $4.00 cy, $0.75 mn
11927	20-35127	Dep. mn. CFSTI $2.00 cy, $0.50 mn
NAS-NRC–	(Non-AEC)	
1351	20-33396	National Academy of Sciences, Washington, D. C. $1.50
NAS-NS–	(Misc.)	
3109	20-33629	Dep. mn. CFSTI $1.75 cy, $1.00 mn
NASA-CR–	(Misc.)	

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54374	20-33872	See N-65-31175
54419	20-33494	See N-66-16920
54977	20-34471	See GA-7064
56191	20-33986	See N-65-32092
58647	20-33987	See N-65-32096
58723	20-33491	See N-65-32113
59212	20-33726	See N-65-32169
59311	20-33943	See N-65-32165
64323	20-33839	See N-65-31950
64343	20-33871	See N-65-30832
64463	20-34079	See N-65-32195
64558	20-34078	See N-65-32048
64562	20-33626	See N-65-32043
64970	20-33944	See N-65-34010
67099	20-34702	See N-65-34392
67106	20-34353	See N-65-34401
67157	20-34417	See N-65-34464
67629	20-33627	See N-66-10648
67631	20-33727	See N-66-10647
67820	20-34006	See N-66-10681
68092	20-34122	See N-66-12247
68107	20-34779	See N-66-12185
68158	20-33730	See N-66-12193
68159	20-33729	See N-66-12189
68181	20-33818	See N-66-12875
68182	20-33752	See N-66-12928
68240	20-34007	See N-66-12863
68298	20-34123	See N-66-12961
68314	20-34008	See N-66-12966
68374	20-33493	See N-66-13000
68435	20-33333	See N-66-13092
68458	20-33731	See N-66-13174
68566	20-34124	See N-66-13638
68622	20-35122	See N-66-13124
68623	20-35123	See N-66-13125
68657	20-34780	See N-66-13563
68841	20-33733	See N-66-17104
69004	20-34355	See N-66-14637
69208	20-34704	See N-66-14955
69853	20-34009	See N-66-16405
69871	20-34356	See N-66-16385
69872	20-34357	See N-66-16393
69883	20-34418	See N-66-16181
69912	20-33840	See N-66-16471
69996	20-34332	See N-66-16250
70013	20-35124	See N-66-16525
70018	20-34706	See N-66-16719
70047	20-34358	See N-66-16697
70151	20-34705	See N-66-16598
70172	20-33732	See N-66-16985
70185	20-34359	See N-66-16975
70320	20-33876	See N-66-17087
70323	20-34707	See N-66-17095
NASA-TM–	**(Misc.)**	
X-1251	20-34708	CFSTI $2.00 cy, $0.50 mn
X-53301	20-34778	See N-65-32252
X-55305	20-33728	See N-66-11201
X-55335	20-34354	See N-66-11230
X-55375	20-34363	See N-66-17248
X-55379	20-34364	See N-66-17252
X-55384	20-34365	See N-66-17257
X-55389	20-34333	See N-66-17261
X-55391	20-34360	See N-66-17230
X-55395	20-34361	See N-66-17233
X-55411	20-34362	See N-66-17243
NASA-TN–	**(Misc.)**	
D-3145	20-33492	See N-66-12158
D-3229	20-34080	See N-66-16939
D-3247	20-33874	See N-66-16420
D-3248	20-33875	See N-66-16551
D-3511	20-33842	CFSTI $2.00 cy, $0.50 mn
NASA-TT–	**(Non-AEC)**	
F-9794	20-34125	For translation see N-66-14060
F-9806	20-35130	See N-66-14377
NEVIS–	**(Misc.)**	
146	20-34204	See CU-1932-252
152	20-34146	See CU-1932-256

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NLCO–		
946	20-33878	Dep. mn. CFSTI $4.00 cy, $0.75 mn
974	20-33257	Dep. mn. CFSTI $1.00 cy, $0.50 mn
977	20-33881	Dep. mn. CFSTI $1.00 cy, $0.50 mn
978	20-33882	Dep. mn. CFSTI $1.00 cy, $0.50 mn
979	20-33154	Dep. mn. CFSTI $1.00 cy, $0.50 mn
NP–	**(AEC File No. for Non-AEC Reports)**	
16013	20-35025	Dep. mn
16094	20-33555	
16124	20-33556	Dep. mn
16125	20-34526	Dep. mn
16128	20-33458	Dep. mn
16129	20-35128	
NP-tr–	**(AEC File No. for Non-AEC Translations)**	
1376	20-34082	Dep. mn. JCL $2.60 fs, $0.80 mf
NRC–	**(Canadian)**	
8991	20-34367	Can. J. Phys., 44: 1361-79(1966)
NRL–	**(Misc.)**	
6405	20-33858	See AD-634094
NUMEC–		
3505-14	20-33945	Dep. mn. CFSTI $3.00 cy, $0.75 mn
NYO–		
2262-102	20-34225	Phys. Rev., 147: 1148-52(1966)
2262-104	20-34224	Phys. Rev., 147: 1144-7(1966)
2262-109	20-34226	Phys. Rev., 147: 1161-5(1966)
2471-19	20-33883	Dep. mn. CFSTI $3.00 cy, $0.75 mn
2794-1	20-34043	J. Geophys. Res., 71: 3251-9(1966)
3242-13	20-33334	Dep. mn. CFSTI $1.00 cy, $0.50 mn
3464-1	20-34854	Solid State Commun., 4: 205-9(1966)
3622-3	20-34889	Dep. mn. CFSTI $1.00 cy, $0.50 mn
ORNL–		
3300(Vol.5)	20-35179	Dep. mn. CFSTI $4.00 cy, $1.75 mn
3888	20-33630	Dep. mn. CFSTI $3.00 cy, $0.75 mn
3969	20-33557	Dep. mn. CFSTI $3.00 cy, $0.75 mn
ORNL-NSIC–		
10	20-33558	Dep. mn. CFSTI $6.50 cy, $2.25 mn
18	20-35180	Dep. mn. CFSTI $2.00 cy, $0.50 mn
ORNL-P–	**(Misc.)**	
1473	20-33008	Int. J. Radiat. Biol., 10: 151-64(1966)
1898	20-33278	Inorg. Chem., 5: 1222-9(1966)
1992	20-33354	J. Chem. Phys., 44: 4510-20(1966)
2037	20-33693	IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 457-67(1966)
2044	20-33289	J. Chem. Phys., 45: 282-95(1966)
2079	20-34564	Nucl. Phys., 84: 545-68(1966)
2097	20-33419	Anal. Chem., 38: 964-5(1966)
2104	20-35175	Nucl. Eng. Design, 4: 108-17(1966)
2161	20-33559	Dep. mn. CFSTI $1.00 cy, $0.50 mn
2163	20-33695	IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 495-507(1966)
2177	20-34890	Dep. mn. CFSTI $1.00 cy, $0.50 mn
2178	20-35026	Dep. mn. CFSTI $1.00 cy, $0.50 mn
2179	20-33604	Dep. mn. CFSTI $1.00 cy, $0.50 mn
2192	20-33414	Dep. mn. CFSTI $2.00 cy, $0.50 mn
2203	20-33845	Dep. mn. CFSTI $2.00 cy, $0.50 mn
2259	20-34569	Nucl. Phys., 84: 609-17(1966)
2262	20-33988	Dep. mn. CFSTI $1.00 cy, $0.50 mn
2264	20-33258	Dep. mn. CFSTI $1.00 cy, $0.50 mn
2265	20-33259	Dep. mn. CFSTI $1.00 cy, $0.50 mn
ORNL-TM–		
1109(Rev.)	20-33846	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1213	20-34907	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1413	20-33459	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1462	20-33676	IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 279-84(1966)
1488	20-35151	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1507	20-33819	Dep. mn. CFSTI $1.00 cy, $0.50 mn
1512	20-34993	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1513	20-34994	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1516	20-33946	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1517	20-33631	Dep. mn. CFSTI $1.00 cy, $0.50 mn
ORNL-tr–		

Report No.	Abstract No.	Availability
1113	20-33187	Dep. mn. JCL $7.60 fs, $2.39 mf
1226	20-35027	Dep. mn. JCL $2.60 fs, $0.83 mf
1229	20-33431	Dep. mn. JCL $3.60 fs, $1.34 mf
1230	20-35028	Dep. mn. JCL $1.60 fs, $0.80 mf
1238	20-33188	Dep. mn. JCL $1.60 fs, $0.80 mf
1239	20-33417	Dep. mn. JCL $1.60 fs, $0.80 mf
1240	20-33189	Dep. mn. JCL $1.10 fs, $0.80 mf
1241	20-33418	Dep. mn. JCL $1.10 fs, $0.80 mf
ORO–		
648	20-32964	Dep. mn. CFSTI $5.00 cy, $1.00 mn
2915-44	20-34262	Dep. mn. CFSTI $1.00 cy, $0.50 mn
2915-45	20-34582	Nucl. Phys., 85: 119-28(1966)
2915-61	20-33970	Dep. mn. CFSTI $1.00 cy, $0.50 mn
2945-4	20-33335	Dep. mn. CFSTI $3.00 cy, $0.75 mn
3065-9	20-34153	Dep. mn. CFSTI $1.00 cy, $0.50 mn
PAN–	**(Polish)**	**(This series of reports was terminated in 1965. Subsequent reports are identified by the code INR)**
PATENTS	**(British)**	**(4s. 6d. each, U. K. Patent Office)**
1,031,371	20-33315	
PATENTS	**(Canadian)**	
732,118	20-33312	
PATENTS	**(German)**	
1,213,930	20-33721	
1,213,931	20-33448	
1,213,932	20-34895	
1,213,933	20-34997	
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1,213,935	20-34986	
1,213,936	20-34896	
1,214,330	20-34688	
1,214,331	20-34689	
1,214,332	20-34774	
1,214,337	20-34897	
1,214,342	20-34002	
1,214,805	20-34987	
1,215,822	20-34988	
1,215,823	20-34898	
1,215,824	20-34899	
1,215,826	20-33857	
1,215,827	20-34143	
1,215,828	20-34900	
1,215,829	20-34989	
PATENTS	**(Japanese)**	
1965-12,999	20-33395	
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Re.26,014	20-33142	
3,246,438	20-33102	
3,250,588	20-33811	
3,250,592	20-33316	
3,250,683	20-34990	
3,250,925	20-33757	
3,250,937	20-33722	
3,251,644	20-33317	
3,251,745	20-35106	
3,252,047	20-34775	
3,253,994	20-35099	
3,253,995	20-34901	
3,253,996	20-35097	
3,253,997	20-34991	
3,253,999	20-35100	
3,254,030	20-33318	
3,254,211	20-33613	
3,254,217	20-33723	
3,254,219	20-33614	
3,254,220	20-33724	
3,254,221	20-33542	
3,254,224	20-33449	
3,254,244	20-34144	
3,257,284	20-34776	
3,259,473	20-33313	
3,259,745	20-33725	
3,259,766	20-35101	
3,260,575	20-33314	
3,260,649	20-34992	
3,260,650	20-34902	
3,260,844	20-33615	
3,260,869	20-34777	
3,261,757	20-34998	
3,261,760	20-34903	
3,262,856	20-35098	
3,262,859	20-34999	
3,262,885	20-35177	
3,263,136	20-34003	
3,263,145	20-33616	
PG-Report–	**(British)**	
177(Rev.)	20-33155	Dep. BIS $8.00. HMSO 40s. 0d.
PNE–		
5004P	20-33434	Dep. mn. CFSTI $2.00 cy, $1.25 mn
PPAD–		
580-E	20-34202	Phys. Rev., 147: 922-31(1966)
PRNC–		
86	20-33336	Dep. mn. CFSTI $1.00 cy, $0.50 mn
Q–	**(Misc.)**	
B2195-1	20-33859	See AD-634128
R–	**(Misc.)**	
161	20-34780	See N-66-13563
298	20-34690	See AD-634274
539	20-34204	See CU-1932-252
553	20-34146	See CU-1932-256
RCN–	**(Dutch)**	
49	20-33916	Phys. Rev., 141: 538-40(1966)
RE–	**(Non-AEC)**	
213J	20-34124	See N-66-13638
215J	20-34122	See N-66-12247
RFP–		
674	20-33261	Dep. mn. CFSTI $2.00 cy, $0.50 mn
708	20-33156	Dep. mn. CFSTI $1.00 cy, $0.50 mn
RISO–	**(Danish)**	
114	20-33337	Dep. mn
RL-SA–		
29	20-33191	Anal. Chem., 38: 954-5(1966)
RL-SEP–		
722	20-33415	Dep. mn. CFSTI $1.00 cy, $0.50 mn
RLO–		
1388B-6	20-34527	Dep. mn. CFSTI $2.00 cy, $0.50 mn
RM–	**(Misc.)**	
4714-NASA	20-34006	See N-66-10681
RN-DR–	**(Non-AEC)**	
0020	20-35122	See N-66-13124
RN-Q–	**(Non-AEC)**	
0036	20-35123	See N-66-13125
RRL–		
2310-180	20-33338	Dep. mn. CFSTI $2.00 cy, $0.50 mn
SC–	**(Misc.)**	
4452D(M)	20-33475	Dep. mn. CFSTI $4.00 cy, $0.75 mn
SC-CR–		
66-2029	20-33884	Dep. mn. CFSTI $3.00 cy, $0.75 mn
SC-RR–		
66-203	20-35152	Dep. mn. CFSTI $1.00 cy, $0.50 mn
66-290	20-33885	Dep. mn. CFSTI $2.00 cy, $0.50 mn
SFL–	**(Finnish)**	
A4	20-33510	Dep. mn
SGAE-PH–	**(Austrian)**	
38/1966	20-33632	Dep. mn

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SID–	**(Non-AEC)**	
64-1295	20-34781	See N-66-16495
SLAC-PUB–		
129	20-34266	Ann. Phys. (N. Y.), 38: 348-62(1966)
139	20-34158	Ann. Phys. (N. Y.), 38: 35-62(1966)
SLAC-Trans–		
43	20-33190	Dep. mn. CFSTI $1.00 cy, $0.50 mn. JCL $1.10 fs, $0.80 mf
SR–	**(Misc.)**	
119	20-33743	See TID-22774
SRIA–		
115P49-1	20-35181	Dep. mn. CFSTI $4.00 cy, $0.75 mn
SSD–	**(Non-AEC)**	
50050R	20-34331	See N-66-13027
STI-DOC–	**(International Atomic Energy Agency)**	
10/55	20-35182	IAEA: $1.00; S21,-; 6/stg.; F Fr 4,-; DM 3,20
STL–	**(Misc.)**	
372-14(2)(Vol.2)	20-33460	Dep. mn. CFSTI $6.00 cy, $1.25 mn
4393-6003-RO-000	20-35124	See N-66-16525
TID–		
22052	20-32942	Int. J. Radiat. Biol., 10: 97-102(1966)
22583	20-33903	J. Nucl. Mater., 19: 341-2(1966)
22629	20-34567	Nucl. Phys., 84: 586-94(1966)
22774	20-33743	Dep. mn. CFSTI $1.25 cy, $0.75 mn
23117	20-33429	Dep. mn. CFSTI $1.00 cy, $0.50 mn
23122	20-33820	Dep. mn. CFSTI $2.00 cy, $0.50 mn
TRG-Report–	**(British)**	
1046	20-33198	Analyst, 91: 347-9(1966)
TT–	**(Canadian)**	
65-50309/4	20-32895	CFSTI $5.00 cy, $1.00 mn
66-31778	20-35187	See JPRS-35342
UCR–		
34P107-33	20-34154	Dep. mn. CFSTI $1.00 cy, $0.50 mn
UCRL–		
7833-T(Rev.1)	20-34337	Mol. Phys., 10: 427-35(1966)
12236	20-35176	Water Resour. Res., 2: 297-331(1966)
12248-T(Rev.1)	20-33435	Dep. mn. CFSTI $1.00 cy, $0.50 mn
14152	20-33886	Dep. mn. CFSTI $1.00 cy, $0.50 mn
14191(Rev.1)	20-33436	Dep. mn. CFSTI $1.00 cy, $0.50 mn
14255	20-34419	Dep. mn. CFSTI $1.00 cy, $0.50 mn
14279	20-34709	Dep. mn. CFSTI $1.00 cy, $0.50 mn
14280(Rev.2)	20-33437	Dep. mn. CFSTI $3.00 cy, $0.75 mn
14282	20-34710	Dep. mn. CFSTI $1.00 cy, $0.50 mn
14297	20-34155	Dep. mn. CFSTI $3.00 cy, $0.50 mn
14633	20-33633	Dep. mn. CFSTI $2.00 cy, $0.50 mn
14668	20-33511	Dep. mn. CFSTI $1.00 cy, $0.50 mn
14719-T	20-34908	Dep. mn. CFSTI $2.00 cy, $0.50 mn
14766	20-33605	Dep. mn. CFSTI $1.00 cy, $0.50 mn
14791	20-33685	IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 370-2(1966)
14822	20-33262	Dep. mn. CFSTI $5.00 cy, $1.00 mn
14917	20-33430	Dep. mn. CFSTI $2.00 cy, $0.50 mn
14918-T	20-34156	Dep. mn. CFSTI $3.00 cy, $0.75 mn
14920-T	20-34263	Dep. mn. CFSTI $1.00 cy, $0.50 mn
14921-T	20-34472	Dep. mn. CFSTI $2.00 cy, $0.50 mn
16195(Rev.)	20-34229	Phys. Rev. Lett., 16: 1221-3(1966)
16414	20-34561	Nucl. Phys., 84: 481-504(1966)
16542	20-33634	Dep. mn. CFSTI $1.00 cy, $0.50 mn
16577	20-34562	Nucl. Phys., 84: 505-33(1966)
16614	20-34296	Phys. Rev., 147: 1117-22(1966)
16686	20-34212	Phys. Rev., 147: 1045-7(1966)
16690	20-34178	Nucl. Phys., 85: 33-9(1966)
16707	20-34081	Dep. mn. CFSTI $3.00 cy, $0.75 mn
16722	20-33675	IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-13: No. 3, 274-8(1966)
16727	20-33989	Dep. mn. CFSTI $1.00 cy, $0.50 mn
16730	20-33560	Dep. mn. CFSTI $1.00 cy, $0.50 mn
16770	20-33887	Dep. mn. CFSTI $2.00 cy, $0.50 mn
16782	20-33888	Dep. mn. CFSTI $4.00 cy, $1.00 mn
16817	20-34420	Dep. mn. CFSTI $3.00 cy, $0.75 mn
16846	20-33889	Dep. mn. CFSTI $3.00 cy, $0.50 mn
16855	20-34103	Phys. Rev. Lett., 17: 1-3(1966)
16870	20-34818	Dep. mn. CFSTI $4.00 cy, $1.00 mn
16882	20-33990	Dep. mn. CFSTI $1.00 cy, $0.50 mn
16899	20-33103	Dep. mn. CFSTI $1.00 cy, $0.50 mn
UCSD–		
10P10-1	20-34286	Phys. Lett., 22: 96-9(1966)
34P127-1	20-35183	Dep. mn. CFSTI $3.00 cy, $0.75 mn
UJV–	**(Czechoslovakian)**	
1498	20-33416	Dep. mn
1512	20-33157	Dep. mn
1513	20-33144	Dep. mn
1571	20-34528	Dep. mn
1576	20-34157	Dep. mn
UR–		
875-101	20-34264	Ann. Phys. (N. Y.), 38: 1-27(1966)
875-104	20-34273	Nuovo Cimento (10), 44A: 321-9(1966)
875-120	20-34305	Physics, 2: 273-89(1966)
875-127	20-34207	Phys. Rev., 147: 965-72(1966)
3591-2	20-34529	Dep. mn. CFSTI $2.00 cy, $0.50 mn
UTIAS–	**(Canadian)**	
100	20-34691	See AD-634596
VUF–		
1025	20-33561	Dep. mn. CFSTI $2.00 cy, $0.50 mn
WANL-TME–	**(Misc.)**	
1153	20-35129	Dep. mn. CFSTI $2.00 cy, $0.50 mn
WAPD-T–		
1781	20-34909	Dep. mn. CFSTI $1.00 cy, $0.50 mn
WAPD-TM–	**(Misc.)**	
582	20-33847	Dep. mn. CFSTI $1.00 cy, $0.50 mn
WCAP–	**(Misc.)**	
3269-62	20-34891	Dep. mn. CFSTI $3.00 cy, $0.50 mn
WIS-TCI–	**(Misc.)**	
111	20-34078	See N-65-32048
111(Pt.2)	20-34079	See N-65-32195
WWO–	**(Misc.)**	
16-R79	20-33456	See EURAEC-1398
X–	**(Misc.)**	
611-65-378	20-34354	See N-66-11230
612-65-400	20-34364	See N-66-17252
615-65-409	20-34365	See N-66-17257
636-65-241	20-33728	See N-66-11201
640-65-389	20-34363	See N-66-17248
640-65-434	20-34360	See N-66-17230
641-65-421	20-34333	See N-66-17261
641-65-451	20-34361	See N-66-17233
641-65-507	20-34362	See N-66-17243
Y–		
1400(Rev.1)	20-35184	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1538	20-33848	Dep. mn. CFSTI $2.00 cy, $0.50 mn
1539	20-35185	CFSTI $3.00 cy, $0.75 mn
1540	20-35186	Dep. mn. CFSTI $3.00 cy, $0.75 mn
1543	20-33158	Dep. mn. CFSTI $1.00 cy, $0.50 mn
Y-EF–		
10	20-33447	Dep. mn. CFSTI $2.00 cy, $0.50 mn

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